

SYSTEM FOR GENERATING A DISCRETE LIQUID PHASE IN A
CONTINUOUS LIQUID PHASE

The invention relates to a device for the generation of a discrete liquid
5 phase in a continuous liquid phase in accordance with the preamble of
claim 1, to a plant having such devices and to a use of this plant.

A method and a corresponding apparatus for the purification of crude oil
are known from WO 2005/100512 (PCT/EP2005/004654). In this
10 purification process, a degassed emulsion is obtained in a first stage which
is separated into water and oil in a second stage. The second stage is
carried out in a container of a purification device which contains a
distribution system for wash water. A phase interface between the water
and oil is brought into contact with the wash water so that a purifying
15 treatment takes place. Due to coalescence of the two phases, they can be
separated from one another. The method can be improved if the emulsion is
brought in droplet form into a continuous phase which consists of wash
water. This is a first purification phase. After coalescence, the oil washed in
this manner forms a second continuous phase into which fresh wash water
20 can be introduced additionally in droplet form or with increased
momentum for support of the cleaning of the phase boundary. A transition
zone in which the coalescence (of both the oil and the water) takes place
results between the two continuous phases. The supply of the emulsion
and of the wash water into the purification device is set such that the
25 transition zone adopts a substantially smaller volume in a predetermined
position than the two continuous phases. There is in each case an optimum
droplet size for the two discrete phases for the wash effect as well as an
optimal shearing of the disperse phases for obtaining a phase separation
which can be determined empirically. The requirement for an optimum
30 purifying process is that it is accomplished to establish the optimum size of

the droplets or drops and to distribute the discrete phases in each case uniformly in the continuous phases. A suitably configured device is required for this purpose.

- 5 It is the object of the invention to provide a device for the generation of a discrete liquid phase in a continuous liquid phase, wherein a shearing of the disperse phase promoting the separation process as well as a production of the predetermined drop size of the discrete phase and its uniform distribution in the continuous phase can be realised. This object is
10 satisfied by the device defined in claim 1.

The device serves for the generation of a discrete liquid phase in a continuous liquid phase with a first or a second liquid. The two liquids coexist as separate phases, have different densities and permit a desired
15 exchange of material. Provision is made to arrange the device in a container which contains the second liquid forming the continuous phase. In a horizontal longitudinal extent, the device includes a distribution member, in particular a cylindrical tube, and a collection passage for the first liquid. The collection passage has an outlet side, a collection side and at least one
20 side wall connecting the outlet side and the collection side. The side wall establishes a connection surface between the outlet side and a horizontal drip edge. This connection surface has good wettability for the first liquid. The side wall has an inclination or a shape which allows for the formation of a liquid film, for this purpose, the sidewall has means for generating a
25 discrete phase in the form of droplets on the outlet side and/or the collection side.

For increasing the stability of the liquid film, the side wall may have a good wettability for the first liquid. The drip edge or the side wall preferably have
30 a profiling, in particular a toothed arrangement for the generation of the

discrete phase in the form of drops which are preferably of equal size due to a uniform toothed arrangement.

Dependent claims 2 to 11 relate to advantageous embodiments of the
5 device in accordance with the invention. A plant in which this device is used is the subject of claims 12 to 14. Possibilities of use of the plant are the subject of claims 15 and 16.

The means comprises a plurality of openings, which allow for a uniform
10 discharge flow of the first liquid out of the inner area along the outlet side and/or the collection side of the side wall. The openings (61) are hole-shaped, jigsaw-shaped, shaped as indentations or as toothed arrangement. Preferably they have a periodically recurring profiling, so that the liquid is directed steadily to the outlet side and/or the collection side of the side
15 wall.

The side wall may have a drip edge, from which droplets of mostly uniform size separate and are integrated into the liquid, which forms the continuous phase. The side wall is either arranged at least partially vertically or has an
20 inclination against the horizontal direction, which lies between 10 and 85 degrees, preferably between 20 and 60 degrees, most preferably between 30 and 40 degrees. Moreover the side wall may have at least one buckle. According to a further embodiment, the side wall has at least on one of its lateral edges a guide element, so that the liquid is directed from the outlet
25 side into the direction of the collection side over the side wall or the openings. The collection side can additionally contain holes for the first liquid and a wall, shielding these holes with a drip edge.

The collection passage comprises additionally at least one deflecting
30 obstacle, in particular a deflecting element, which is arranged in front of

the outflow openings of the distribution member and through which a first liquid is deflectable into the inner zone of the collection passage to the collection side, whereby the outflow openings of the distribution member are arranged in particular along a linear strip and the deflecting element is
5 arranged oppositely to said linear strip and forms an contiguous, planar or concave deflecting area.

The plant comprises a container which comprises a base and lateral walls, as well as a plurality of devices arranged in the container as outlined above.
10 These devices, in the following named lower devices, are arranged in the vicinity of the base and their discharge sides are open downwardly and/or such or further devices, in the following called upper devices, are arranged in an upper portion of the container and their discharge sides are open upwardly, whereby in the case of the lower devices the base may be a
15 deflecting obstacle for the liquid flowing out of the distribution member. Horizontal cross sectional areas of the container are in particular covered homogeneously by the devices, whereby the devices are preferably arranged in parallel. Lower as well as upper devices are foreseen, such that the lower devices are foreseen for feeding the light liquid and the upper devices for
20 feeding a heavy liquid into the container, that moreover a discharge conduit and a discharge member are arranged on the bottom of the container comprising in particular a discharge conduit and/or an overflow weir is arranged above the upper devices.

A plant as outlined above is used in particular for the cleaning of raw oil,
25 whereby the light liquid is a raw oil to be cleaned and in the upper zone of the container the water as discrete phase absorbs contaminating matter from the raw oil and in the lower zone of the container the water acting as second continuous phase absorbs contaminating matter from the ascending oil droplets, whereby between the two continuous phases, there
30 is a zone, in which the discrete phases merge by coalescence to the

corresponding continuing phases. The plant can in particular find application on a floatable platform or transport means, such as a ship.

The invention will be explained in the following with reference to the
5 drawings. There are shown:

- Figs. 1 – 3 a first embodiment of the device in accordance with the invention; furthermore a second and third embodiment; and
- 10 Fig. 4 a plant with devices in accordance with the invention arranged in a container.
- Fig. 5 a further embodiment of the device according to the invention with further design options for the wall edge and the drip edge
- 15 Fig. 6 a further embodiment of the device according to the invention with a curved side wall.
- 20 A first embodiment of the device 1 in accordance with the invention, which is shown as a detail in Fig. 1, permits the generation of a discrete phase with a first liquid in a continuous phase which consists of a second liquid. The two liquids form coexisting phases which permit a desired exchange of materials. They have different densities. Provision is made to arrange the device 1 in accordance with the invention in a container (cf. Fig.4: container 9) which contains the second liquid forming the continuous phase. In a horizontal longitudinal extent, this device 1 includes a distribution member 2, in particular a cylindrical tube, and a collection passage 3 for the first liquid with the collection passage 3 having an outlet side 4, a collection side
- 25 30

5 and at least one side wall 6 connecting the outlet side 4 and the collection side 5. The two phases are in contact at the outlet side 4 and permit an mass and momentum transfer. In the example shown, the first liquid is lighter than the second. The outlet side 4 is therefore open towards the bottom. In accordance with the invention, the collection passage 3 additionally includes a deflection member 8 (or a deflection obstacle) which is arranged in front of the outlet openings 20 of the distribution member 2. A plurality of distribution members 2 and corresponding deflection members 8 can also be provided.

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The outlet openings 20 of the distribution tube 2 are arranged on a linear strip and the deflection member 8 preferably forms a contiguous concave deflection surface with respect to this strip. The device 1 in accordance with the invention can also be arranged directly above a container base. In this case, a separate deflection member 8 can be dispensed with: the base of the container takes over its function. The base extending in the region of the output side 4 is a deflecting obstacle which is also considered part of the collection passage 3.

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20 The outlet openings 20 can also be arranged laterally at the distribution tube 2 and directed upwardly. In this case, no separate deflection member 8 is needed either; the side wall 6 acts as a deflecting obstacle.

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The first liquid is discharged downwardly in jet form from the distribution member 2, impacts on the deflecting obstacle or deflection member 8 and is deflected by it upwardly towards the collection side into the inner region 30 of the collection passage 3. The flow is calmed by the impact. With a very large longitudinal extent of the device 1 (for example over 30 m) and a cylindrical distribution member 2, it can be advantageous to provide a first

distribution tube coaxially in the distribution member 2 for a first stage of the liquid distribution.

The first liquid, i.e. the lighter liquid, is guided to the outer side of the side wall 6 via a plurality of openings 61 which are arranged in the side wall 6 on the outlet side 4 and permit a uniform outflow from the inner area 30. The openings 61 are configured in the form of incisions in an open manner toward a wall edge 62; however, they can also be in the form of holes. The side wall 6 establishes a connection surface 6 between the outlet side 4 and a horizontal drip edge 7, which has an inclination and a shape enabling the formation of a liquid film of the discrete liquid phases. The inclined side wall 6 provides the necessary surface for film formation. By means of shaping, e.g. by rounding of the zone of the liquid outflow in the lower end of the side wall 6, the formation of the film on the side wall 6 can be supported by means of decreasing the relative velocity between the liquid phases. For enhanced stability of the film said side wall 6 may have a good wettability for the first liquid. The good wettability can be achieved, for example, by a preparation of the surface 60 before a putting into operation in that it is coated with a film of the first liquid. Furthermore a roughened surface 60 may increase the wettability.

The drip edge 7 has a toothed arrangement 70 by means of which the generation of the discrete phase in the form of drops is made possible. The toothed arrangement 70 is preferably uniform so that drops arise which are all of the same size or of largely the same size.

According to a further embodiment, which is shown in fig. 5, the lower wall edge 62 of the side wall has a profiling itself. This profiling is formed of substantially periodically arranged peaks and valleys or is especially formed as toothed arrangement or a wave profile. Openings 61 may be added to the

profiling and may in addition thereto or alternatively also comprise hollow spaces.

The connection surface 60 on the outer side of the side wall 6 lies, in Fig. 1,
5 together with the drip edge 7 in a plane which is aligned vertically or in an angle to the vertical direction. The angle of inclination between this intersecting line of the plane and a horizontal plane with a vertically arranged intersecting plane is in the range of 10 to 85 degrees, preferably between 20 and 60 degrees, with particular preference between 30 and 40
10 degrees. In Fig. 1 there are two side walls 6 in a specular symmetrical arrangement. At least one of those two side walls can have the inclination mentioned above. The device 1 can also have only one side wall 6 as the second embodiment of Fig. 2 illustrates. The deflection member 8 only allows the first liquid to flow off at one side. In this example, moreover, the
15 side wall 6 is inclined. With such an inclined position, it is advantageous for the toothed arrangement 70 of the drip edge 7 to lie in a plane which is inclined away from the vertical plane and from the distribution member 2. A lower part of the side wall 6 can also have a different inclination to the plane spanned by the toothed arrangement 70.

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Fig. 3 shows a third embodiment in which the collection side 5 additionally contains holes 50 for the first liquid. A wall 6' shielding these holes 50 is provided which has a drip edge 7' with a toothed arrangement 70'. A further connection surface (on the non-visible surface of the wall 6')
25 extends between the holes 50 and the drip edge 7' and has the same properties as the drip edge 6.

A further embodiment of the device 1 with a side wall 6, which comprises a wall edge 62 formed as a profiling is shown in Fig. 5. The wall edge of the inclined side wall 62 is therein equipped with a toothed arrangement
30 whereas the rear side wall, shown as vertical side wall 6 is provided with

ribs. The shape and depth of the profiling depends on the nature of the flowing liquid, as well as the amount thereof. It is advantageous to foresee sufficiently long ribs, for enabling a uniform outflow from the side wall 62 even if said side wall is not arranged completely horizontally. The drip edge
5 7 also is provided with a profiling. In this example, wave-like profilings are shown, however any other combination of profilings is possible. Additionally, borings can be foreseen in the side wall and/or a combination with openings 61, what is not shown in the drawings.

10 Fig. 6 shows a further embodiment of the device, in which the side wall 6 has a curvature pending into the direction of the collection passage 3. In the zone of the liquid discharge, the gradient of velocity of the velocity component in discharge direction between the two liquids can be decreased, whereby the generation of the film and the stability of the film
15 on the side wall are supported. It is self-evident, that the edge of the side wall 62 and/or the drip edge can have any of the profilings or shapes described earlier. For simplicity, only a part of the device is shown in Fig. 6, which may be either specularly arranged, as shown in Fig. 1 or allow for a unilateral discharge of liquid, as shown in Fig. 2.

20 Not shown in the drawings is a device with a side wall, which has at least one buckle. Moreover the side wall 6 can have a guide element on at least one of its lateral edges. This guide element can be formed as a flap. This guide element directs the liquid flowing over the outlet side 4 along the
25 openings 61 as well as the side wall 6 in direction of the described passageway. By the guide element, it is in particular avoided, that liquid flows over the lateral edges of the side wall 6.

The device 1 in accordance with the invention is provided for a plant in
30 which it is arranged as one of a plurality of devices 1 configured the same.

The distribution members 2 are as a rule connected in the form of a parallel circuit to a common supply line (not shown). In the plant 10 shown schematically in Fig. 4 with devices in accordance with the invention, upper devices 1' and lower devices 1" can be distinguished. These devices 1', 1" are arranged in the container 9. The lower devices 1" are arranged adjacent to the base 90 and their outlet sides 3" are open towards the bottom. The upper devices 1' are arranged in an upper region of the container 9; their outlet sides 3' are open towards the top. Horizontal cross-sectional surfaces of the container 9 are respectively uniformly occupied by the devices 1', 1"; in this connection, the devices 1', 1" are preferably aligned in parallel.

In the plant 10, the upper devices 1' are provided for a heavy or heavier liquid 11 and the lower devices 1" are provided for a light or lighter liquid 12. A drain line 11' for the heavy liquid 11 is connected to the base 90 at the container 9. There is at least one outflow member, which in particular includes a drain line 12' and/or an overflow weir (not shown), for the light liquid 12 over the upper devices 1'.

The treatment of an oil/water emulsion with a wash water is provided as a preferred use of the plant 10. In this case, the heavy liquid is water and the light liquid is a crude oil to be purified which has already been degassed. In the upper region of the container 9, the water as a discrete phase absorbs pollutants from the oil which forms a continuous phase 120. In the lower region of the container 9, the water as a second continuous phase 110 absorbs pollutants from rising oil droplets. A zone 130 is disposed between the two continuous phases 110 and 112 and the discrete phases merge in it to form the corresponding continuous phases by coalescence. In an upper layer 121 of the zone 130, the oil droplets have largely combined to form the continuous phase 120. The water droplets falling from above absorb residues of water which are still left in the layer 121. The same

applies accordingly in reverse to a lower layer 112 in which the water predominates.

Uses of the device 1 in accordance with the invention are naturally also
5 conceivable in which only a heavy or a light liquid is to be introduced into a light or heavy liquid in drop form.

The plant described above can also be used on a ship on which the horizontal alignment can only be realized in a time mean due to the
10 habitually occurring rolling movements. The horizontal longitudinal extent of the distribution tubes or collection passages 3 therefore relates to a mean position which would be present in a stationary, floating ship or in a floatable platform.

Claims

1. A device (1) for the generation of a discrete liquid phase of a first liquid in a continuous liquid phase of a second liquid, wherein the two liquids which can coexist as separate phases while permitting a desired exchange of material have different densities and wherein the device is arranged in a container (9) which contains the second liquid forming the continuous phase,
said device including a distribution member (2), , and a collection passage (3) for the first liquid, with the collection passage (3) having an outlet side (4), a collection side (5) and at least one side wall (6) connecting the outlet side and the collection side,
characterised in that the side wall (6) comprises means for generation of a discrete phase in the form of droplets on the outlet side (4) and/or the collection side (5).
2. The device (1) in accordance with claim 1, wherein the means comprises a plurality of openings (61), which allow for a uniform outflow of the first liquid from the inner zone (30) along the outlet side (4) and/or the collection side (5) of the side wall (6).
3. The device (1) in accordance with claim 2, wherein the openings (61) are hole-shaped, jigsaw-shaped, shaped as indentations or as toothed arrangement.
4. The device (1) in accordance with any of the claims 1 to 3, whereby the side wall (6) comprises at least a drip edge (7).

5. The device (1) in accordance with any of the preceding claims, whereby the side wall (6) is arranged at least partially vertically.
6. The device (1) in accordance with any of the preceding claims, wherein the side wall (6) comprises an inclination with respect to the horizontal direction, which lies between 10 and 85 degrees, preferably between 20 and 60 degrees, most preferably between 30 and 40 degrees.
7. The device (1) in accordance with any of the preceding claims, wherein the side wall comprises at least a buckle.
8. The device (1) in accordance with any of the preceding claims whereby the side wall comprises a guide element on at least on of its lateral edges.
9. The device (1) in accordance with any of the preceding claims wherein in the collecting side (5) additional holes (50) for the first liquid and a wall (6') for shielding these holes with a drip edge (7').
10. The device (1) in accordance with any of the preceding claims, wherein the side wall has a good wettability for the first liquid.
11. The device (1) in accordance with any of the preceding claims, wherein the collection passage additionally includes at least one deflecting obstacle, in particular a deflection member (8), which is arranged in front of the discharge openings (20) of the distribution member (2) and by which the first liquid can be deflected towards the collection side (3) into an inner region (30) of the collection passage.

12. The device (1) in accordance with any of the preceding claims, with the discharge openings (20) of the distribution member (2) being arranged on a linear strip and the deflection member (8) forming a contiguous concave deflection surface with respect to this strip.
13. The device (1) in accordance with any of the preceding claims, wherein the distribution member (2) is a cylindrical tube.
14. A plant (10) having a container (9) which includes a base (90) and side walls as well as having a plurality of devices (1; 1', 1'') arranged in the container in accordance with any one of the preceding claims, characterised in that such devices, called lower devices (1'') in the following, are arranged adjacent to the base; and in that their outlet sides (3'') are open towards the bottom; and/or in that such or further devices, called upper devices (1') in the following, are arranged in an upper region of the container; and in that their outlet sides (3') are open towards the top, with, in the case of the lower devices, the base being able to be a deflecting obstacle for liquid discharged from the distribution member (2)..
15. The plant (10) in accordance with claim 14, wherein horizontal cross-sectional surfaces of the container (9) are uniformly occupied by the devices (1; 1', 1''), with the devices preferably being aligned in parallel.
16. The plant (10) in accordance with claim 14 or claim 15, wherein both lower and upper devices (1', 1'') are provided; in that, for the feeding into the container (9), the lower devices (1'') are provided for a light liquid (12) and the upper devices (1') are provided for a heavy liquid (11); in that furthermore a drain line (11') for the heavy liquid or for the light liquid, at least one outflow member which in particular

includes a drain line (12') and/or an overflow weir are arranged above the upper devices.

17. Use of a plant in accordance with any one of claims 14 to 16, wherein the heavy liquid (11) is water and the light liquid (12) is a crude oil to be purified; and in that, in the upper region of the container (9), the water as the discrete phase absorbs pollutants from the crude oil, that is from the continuous phase (120), and, in the lower region of the container, the water as the second continuous phase (110) absorbs pollutants from rising oil droplets, with a zone (130) being disposed between the two continuous phases and the discrete phases merging to form the corresponding continuous phases by coalescence in it.
18. Use of the plant in accordance with claim 17 on a floating platform or on a transport means such as a ship.