

MULTIPHASE SEPARATOR

5

The present invention relates to multiphase separators.

In several industries, such as in the production and
10 processing of mineral oil, mixtures of more or less
immiscible substances, such as different liquids,
gases and sometimes solids, are produced, and such
mixtures are sometimes obtained under pressure.

15 Demixing of such a mixture can of course, occur by
leaving it standing for some time. The undissolved
gases and vapours of volatile components (if any) can
be collected, whereas the immiscible liquids will
separate in different layers and the solids will form
20 a sediment.

This is not a suitable technique for large quantities.
The invention provides a device for this purpose in
which different components of such mixtures can be
25 separated in a continuous manner.

The present invention provides a multiphase separator, comprising a gas-tight tank with a substantially horizontal axis, which tank comprises a supply connection at one end for the liquid to be treated, a plurality of discharge connections for the different gaseous, liquid or solid components and a plate separator arranged within said tank comprising inclined parallel corrugated plates adapted for cross-flow separation, an inlet window such that the liquid is forced to flow through the passages between the plates, and an overflow weir arranged at the other side of said separator for determining the normal liquid level in said tank, the discharge connections being situated so that the different components in the tank and in the cross-flow separator can be discharged separately from one another.

Since a cross-flow separator allows a horizontal passage of the liquid flow, the lighter and heavier components are separated from a main flow in the transverse direction. Multi-component mixtures can be treated in a continuous flow. The gases collect in the upper part above the liquid level determined by the overflow weir. Furthermore, a lighter liquid can float on the liquid mass and can be discharged by means of suitable overflow gutters, whereas the heavy

components, in particular any heavy liquid or solid components, are collected below the separator and can be separately discharged.

- 5 In the case of a pressurised system the discharge means is preferably provided with suitable valves which are adapted to be opened at intervals for discharging the above-mentioned components. If required separate collecting vessels can be arranged
10 inside the tank for facilitating the discharge.

Such tanks will often have large dimensions. Pressure tanks generally have a cylindrical shape, and at least at one end a closing lid will be provided. Such
15 vessels are generally constructed by specialised factories, and, in the case of pressure tanks, have to be tested for strength and leakproofness. Preferably the separator is arranged in such a tank later. This requires an expensive end cover with heavy flanges,
20 and opening and closing again such a cover for arranging a plate separator will be objectionable.

Accordingly in a preferred embodiment a cross-flow separator is used which is composed of a plurality of
25 units which are each adapted to be introduced through a manhole provided in a wall of the tank, and in

(13)

particular in an end wall or cover, which units can be arranged inside the tank side by side, behind and/or above one another.

- 5 In this manner it becomes possible to initially manufacture the tank in a specialised factory, and to test it for strength and leakproofness, and afterwards transport it in the closed condition to its destination where only the manhole is opened for
10 allowing the inside of the tank to be finished and for arranging therein the separator and associated elements.

Preferably supports are used on which said units can
15 be kept in place. The supports, moreover, can serve as parts of partition baffles defining spaces for collecting components separated between the plates. Additional baffles can be arranged above these units for completing the partition baffles and for defining
20 a collecting space also at the upper side.

In particular such plate units can be juxtaposed in pairs each with an opposite plate inclination. The adjoining corrugated longitudinal edges of
25 corresponding plates of two adjacent units then define, because of their corrugations, apertures

through which light components, including gases, separated between the plates can slide away along the plates to escape towards the collecting space.

- 5 In a further preferred embodiment the assembly of plates is positioned between two longitudinal walls for laterally defining the separation space, and the spaces outside these walls, if separated from the main space of the tank, can, if desired, be used as
10 collecting spaces for separated components.

Between the terminal baffles of the plate assembly additional supporting baffles can be provided which can define separate collecting chambers for separated
15 components, such chambers can be provided with separate discharge connections, and also vertical baffles can be present for preventing the liquid from flowing outside the separation passages and around the plate assembly.

20

Furthermore grids of lattice-work can be provided between pairs of plate units arranged above and/or behind one another so as to prevent plates of an adjoining unit penetrating into the spaces between the
25 plates of the other unit. These grids or lattice-works will, furthermore, equally distribute the weight of a

15

superposed unit, and will prevent short-circuit liquid flows between such units.

An embodiment of the invention will now be described,
5 by way of example only, with reference to the accompanying diagrammatic drawings, in which:

Fig. 1 is a diagrammatic cross-section of a separator;
device;

10

Fig. 2 is a diagrammatic cross-section of a plate unit of the cross-flow separator of the separator of Figure 1;

15 Fig. 3 is a cross-section of this plate separator;

Fig. 4 is a diagrammatic partial cross-section on a larger scale of a part of Fig. 3; and

20 Fig. 5 a simplified diagrammatic representation of a multiple-unit separator for a separator device.

A tank 1 shown in Fig. 1 is provided, at its left-hand end, with a supply connection 2 for the liquid to be
25 treated. This liquid consists, for example, of water having suspended therein oil, heavy liquid or solid

components, and non-dissolvable gas or a volatile liquid which can be separated by evaporation.

The other end of the tank is closed by an end wall 3 in which a manhole 4 with a cover is provided. If necessary additional manholes 4' can be provided in the upper wall of the tank. An overflow weir 5 extending over the full width of the tank determines the normal liquid level 6 in the part between the supply 2 and the overflow 5. In the other part between the overflow 5 and the end wall 3 a discharge 8 provided with a valve 7 for the liquid 9 flowing over the overflow weir 5 is provided, by means of which this liquid can be removed. Above the liquid a gas space 10 is present in which gas escaping from the liquid will be collected. This gas can be removed by means of a duct 11 with a valve 12.

Between two baffles 13 extending above the liquid level 6 an assembly 14 of corrugated plates is arranged. These plates are positioned mutually parallel and substantially parallel to the longitudinal axis of the tank 1. The corrugations are directed transversely to this longitudinal axis.

This assembly 14 is supported between the baffles 13 by means of an intermediate baffle 15. More than one baffle 15 can be present. Between the baffles 13 and 15 chambers 16 are defined each of which communicates with a duct 18 provided with a valve 17. It is also possible to use intermediate baffles 15 which only act as supports, so that a single discharge duct is sufficient.

10 The device shown is adapted for four-phase separation, in which a lighter liquid is separated in the separator 14 from the carrier liquid, and will, then, float between the baffles 13 to form a floating layer 19 on the liquid surface 6. An overflow gutter 15 20 serves to remove this floating layer. The gutter 20 communicates by means of a duct 21 with a collecting vessel 22 isolated from the liquid flow. The vessel 22 is connected to a discharge duct 23 with a valve 24. The vessel 22 is placed in such a manner 20 that components already floating before the separator 14 can flow directly over the edge of this vessel. It is also possible to extend the intermediate baffles 15 upwards above the separator so as to divide the flotation space thereabove into partial spaces if this 25 is favourable for the separation. Each partial space is then provided with separate discharge means for its

floating layer.

In the chamber 25 situated between the overflow weir 5 and the rear baffle 13, in which the liquid which has passed through the assembly 14 is collected before flowing off over the overflow weir 5, after-separation by precipitation, e.g. of a heavier liquid, can take place. Discharge of the heavier liquid can take place through a duct 27 provided with a valve 26. The duct 2 opens into a collecting dome 28 formed in the bottom of tank 1.

If the liquid which has passed through the plate assembly 14 has a smaller volume than the lighter flotating liquid, the former can be discharged through the duct 27. Then the lighter liquid can flow over the weir 5, in which case the rear baffle 13 should be made lower.

When the plate assembly 14 is to be arranged in such a tank after the latter has been manufactured and has been tested in the closed condition, it can be objectionable to remove the end wall 3 again. Therefore an assembly 14 is preferably used which is assembled from a plurality of partial units which can each be introduced through the manhole 4.

Fig. 2 shows a cross-section of such a unit 29, consisting of a plurality of corrugated plates 30 connected together by means of tensioning bolts and spacers 31 to form a coherent assembly. The end plates 29' are somewhat shorter than the other ones, but not so short that their surface area is so small that two corner portions 32 of the rectangle defined by the plate unit are not filled.

10

Such units can be juxtaposed in the manner shown in Fig.3. Lateral plates 33 border the assembly. The units 29 bear on at least two bottom supports 34 one of which lies in the plane of Fig.3. The supports 34 each have a central projection 35 having the shape of two joined corner recesses 32 of the adjacent units 29. Above each support 34 an upper plate 36 is arranged which has two corner projections 37 fitting into the corner recesses 32 of these plate units. Together the plates 34 and 36 form a baffle 13. The other baffle 13 as well as any intermediate baffles can be assembled from such supporting plates, 34, 36. If necessary, such an intermediate baffle can be provided at one side only of the units.

Depending on the dimensions of the tank and the desired separation effect, several units of this kind can be arranged behind one another and, if necessary, also on top of one another.

5

Fig. 4 shows the manner in which the plates of such units join one another in the arrangement of Fig. 3. At the lower side the tops 38 of the various superposed plates contact the lateral wall 33. The valleys 39 are spaced from said wall so that sediment sliding down through the valleys can slide downwards along the lateral wall 33. It is also possible, as represented at the right-hand side of Fig. 4, to use auxiliary baffles 40 engaging the tops so that between these auxiliary baffles discharge channels for heavy components are defined.

At the higher side the valleys of corresponding plates of both units engage one another, so that, now, passages between the tops 38 are obtained through which lighter components can escape upwards. If necessary vertical baffles corresponding to baffles 40 can be arranged also between two juxtaposed units.

25

The units can also be juxtaposed with joining lower sides, and then the lighter components will move upwards near the lateral walls 33. The appropriate arrangement depends on the character of the multiphase mixture and of the components to be separated.

Furthermore it will be clear that the number and location of the various discharge connections depends on the character of the multiphase mixture. Sometimes it can be advisable to arrange the connections in a bulge of the tank in which the component in question can collect, e.g. as shown at 28.

If the mixture to be treated is supplied under pressure, a pressure-proof tank should, of course, be used, and the valves should then be opened at intervals. Care should be taken that the pressure is sufficiently throttled.

Furthermore it is possible to use the space between the lateral walls 33 and the tank wall as discharge or storage spaces for separated components.

An important advantage of the described plate assemblies composed of smaller units which can be introduced through a manhole is that arranging the

plate assemblies can be done after completing all other operations, including testing the tank. The units can be easily removed for cleaning and repair. It is also possible to add further units afterwards if
5 a larger capacity is required. This can be a particular advantage in the case of off-shore installations where it is very objectionable or even impossible to remove the end wall 3.

10 When several units are to be stacked or juxtaposed in the axial direction, it is often very difficult to obtain a sufficient continuity of the corresponding passages between the corrugated plates of adjacent units.

15

In the case of units juxtaposed in the axial direction, the corrugations of adjacent units will seldom form a continuous wave, and, if the plates of one unit penetrate into the passages between plates of
20 the other unit, the passages will be narrowed, and will be easily obstructed by sediment accumulated there.

In the case of superposed units the plates of the
25 upper unit should be supported by the lower one, and, since the plates are not necessarily exactly

aligned, additional means should be used for supporting them. If a small distance is left between such units, longitudinal liquid flows will disturb the transfer of separated components sliding along the plates of one unit towards the other unit.

These difficulties can, in both cases, be avoided by interposing between two adjoining plate units a grid or lattice-work made of flat strips which extend at an angle relative to the corrugated plates of the adjacent units. These strips are brought into contact with the plates.

Such grids can consist of at least one set of parallel strips, and preferably of two sets intersecting one another at an angle, ideally 90° . Such grids or lattice-works will prevent the corrugated plates from penetrating into the passages of the adjacent unit, and, moreover, ensure a smooth flow of liquid or separated components from one unit towards the next. In the second case such grids will evenly distribute the weight of the upper unit over the lower one, and, moreover, will prevent axially directed liquid flows from flowing through the interspace between the units.

24

Fig. 5 shows diagrammatically grids 41 arranged between two superposed units 29, and a grid 42 arranged between two units juxtaposed in the axial direction.



CLAIMS

1. A multiphase separator, comprising a gas-tight
5 tank with a substantially horizontal axis, which tank
comprises a supply connection at one end for the
liquid to be treated, a plurality of discharge
connections for the different gaseous, liquid or solid
10 components, and a plate separator arranged within said
tank comprising inclined parallel corrugated plates
adapted for cross-flow separation, an inlet window
such that the liquid is forced to flow through the
passages between the plates, and an overflow weir
arranged at the other side of said separator for
15 determining the normal liquid level in said tank, the
discharge connections being situated so that the
different components separated in the tank and in the
cross-flow separator can be discharged separately from
one another.

20

2. A separator as claimed in claim 1, adapted for
treating a pressurised liquid mixture, wherein the
discharge connections are each provided with a valve.
- 25 3. A separator as claimed in claim 2, further
comprising separate collecting vessels for collecting



separated components and each connected to an associated discharge duct provided with said valve.

4. A separator as claimed in claim 3, further
5 comprising an overflow gutter for collecting
components floating on the liquid surface, wherein the
collecting vessel connected to said gutter is arranged
before the plate separator and is provided with an
overflow edge so as to be adapted to collect
10 components which float before reaching the plate
separator.

5. A separator as claimed in any one of the preceding
claims, wherein the tank is provided with at least one
15 manhole and wherein the plate separator is composed of
units which are stacked side by side, behind and/or
above one another, the dimensions of each such unit
being such that it can be introduced through the
manhole.

20

6. A separator as claimed in claim 5, further
comprising supports arranged in the tank, which are
adapted to the shape of a said unit, and which,
together with adjoining parts, form a partition baffle
25 for defining a separator space.

27



7. A separator as claimed in claim 5 or 6 wherein the said plate separator units are juxtaposed in pairs with opposite slope, so that between adjoining parts of plates of different units passages for components separated between the plates remain free.
8. A separator as claimed in any one of the preceding claims 5 to 7, wherein the plate separator is arranged between two longitudinal walls laterally defining a separation space, the spaces outside these walls being separated from the main space of the tank.
9. A separator as claimed in any one of the preceding claims, wherein additional supporting baffles for the plate separator between which separate collecting chambers for separated components are defined, which are provided with separate discharge means.
10. A separator as claimed in any one of claims 5 to 8, wherein grids or lattice-works are provided between pairs of said plate separator units arranged above and/or behind one another.
11. A multiphase separator substantially as hereinbefore described with reference to the accompanying drawings.