

SEPARATING APPARATUS

Description

The invention relates to a separator device having the features specified in the preamble of claim 1. Such a separator device is known, for example, from CN 106946370 A.

Separator devices are conventionally used for the treatment of wastewater from buildings. For example, large-scale kitchens, petrol stations, and other commercial establishments can be equipped with separator devices to remove coarse and fine solid particles as well as grease and oils from wastewater before the water enters the sewage system.

To enable thorough preliminary purification, such separator devices can include several different units for the stepwise treatment of wastewater. For example, the separator device disclosed in the aforementioned CN 106946370 A comprises an inlet unit for feeding the wastewater, a separator tank for separating grease, oil, and sludge, as well as an outlet pipe for discharging the treated wastewater and a collection pipe for the separated grease and oil.

Furthermore, according to CN 106946370 A, the separator tank designed for separating oil and grease includes an oil/grease outlet pipe for discharging the separated oils and greases. In order to vent air from the separator tank, a vent pipe is arranged in the upper section of the tank. The separator device consists of numerous components and has a complex construction.

The objective of the invention is to improve the separator device known from the aforementioned prior art in such a way that reliable separation of fat, oil, and water is achieved with a simplified structural design.

According to the invention, this object is achieved by a separation device comprising the features of claim 1.

Specifically, the objective is achieved by means of a separator device for separating oil, grease, or other residues from wastewater, comprising a separator tank and an inlet system, in particular an inlet pipe. The inlet system is designed

to accommodate a maximum wastewater inflow rate Q into the separator tank. The separator device includes an outlet pipe for the discharge of purified wastewater, featuring a first inlet opening and a first outlet opening, and a collection pipe for the separated oil and/or grease, featuring a second inlet opening and a second outlet opening. The first outlet opening forms a first, in particular horizontal, overflow edge over which the purified wastewater flows during operation. The second outlet opening forms a second, in particular horizontal, overflow edge over which the separated oil and/or grease flows during operation. The second overflow edge is positioned higher than the first overflow edge. A vertical distance d is defined between the two overflow edges. During operation, at the maximum wastewater inflow rate Q , an overflow height d_0 of the purified wastewater is established at the first overflow edge in the vertical direction.

Accordingly, the following applies:

$$d \geq \text{essentially } 1.1 * d_0$$

To retain fats and/or oils through the separation of the water surfaces, the principle of communicating vessels is utilized. When the outlet pipe and the collection pipe are completely filled with wastewater, the heights of the liquid columns in equilibrium are inversely proportional to their specific weights. The second overflow edge of the collection pipe is positioned higher than the first overflow edge of the outlet pipe. Due to the height difference between the two overflow edges, different liquid levels form in the outlet pipe and the collection pipe. In this context, it should be noted that the vertical distance d between the two overflow edges is dimensioned such that d is at least 10% greater than the overflow height d_0 . The overflow height d_0 corresponds to the height that occurs at maximum wastewater inflow rate Q . The maximum wastewater inflow rate Q is a fixed characteristic parameter of the separator device.

It has been shown that such an arrangement of the two overflow edges provides greater reliability in the separation of fat and/or oil and contributes to a secure phase separation. The arrangement of the overflow edges described here plays a decisive role in maintaining the interface between the water and the fat and/or oil below the level of the second overflow edge.

To ensure reliable separation of fat, oil, and water during operation at the maximum inflow rate Q , the lower limit of d can, for example, be determined experimentally using the overflow height d_0 . The lower limit of d indicates how large d should or must be at minimum to prevent wastewater from reaching the second overflow edge and entering the fat collection chamber. To avoid the wastewater rising up to the second overflow edge, d is selected such that $d \geq 1.1 * d_0$. In particular, d may be: $d \geq 1.3 * d_0$, $d \geq 1.5 * d_0$, $d \geq 2.0 * d_0$, $d \geq 2.5 * d_0$, $d \geq 3.0 * d_0$, $d \geq 3.5 * d_0$, $d \geq 4.0 * d_0$, $d \geq 4.5 * d_0$, and in particular, $d \geq 5.0 * d_0$.

To measure the overflow height d_0 that develops during operation, a measuring rod can be used, for example. In this process, the measuring rod is positioned vertically at the first overflow edge, and the resulting overflow height d_0 is read from the water mark that forms on the rod.

At maximum flow velocity, the maximum wastewater inflow rate Q is established in the separator tank.

As an alternative to the simple measurement method, the overflow height d_0 can be determined and calculated using the Francis equation as follows.

To determine the maximum inflow rate Q as a function of the overflow height d_0 , the Francis equation, known from hydraulic engineering, is used:

$$Q = \frac{2}{3} \mu \sqrt{2g} B \sqrt{d_0^3}$$

The Francis equation can be derived in form from the relationship for the maximum discharge. The discharge coefficient μ is a dimensionless factor in hydraulic engineering used to calculate the volume of water flowing over the overflow edge. It depends on the shape of the overflow and the influence of the wastewater inflow velocity. A reference value for rectangular overflow edges is $\mu \approx 0.6$. For other shapes of overflow edges, the discharge coefficients deviate to a greater or lesser extent.

The gravitational force (acceleration due to gravity) g has a value of $g = 9.81 \frac{m}{s^2}$ at the Earth's surface.

B is referred to as the width of the overflow. The width B of the overflow is established at the first overflow edge as a function of the wastewater inflow rate Q.

The separator device according to the invention has a simple structure comprising a separator tank, an inlet system for supplying the wastewater to be treated, an outlet pipe for discharging the purified wastewater, and a collection pipe for the separated oil and/or grease. The simple design does not exclude the presence of additional components.

The residues contained in the wastewater settle by gravity in the lower part of the separator tank. Oil and grease are not soluble in water. Since they have a lower specific gravity than water, they rise to the surface. As a result, the mixture of oil and/or grease and water separates into an oily phase and an aqueous phase. The oil and/or grease droplets coalesce and rise into the collection pipe. The purified wastewater is discharged through the outlet pipe and flows, for example, into the sewage system.

Preferred embodiments of the invention are specified in the dependent claims.

Preferably, the outlet pipe and the collection pipe are arranged vertically, at least in the region of their respective overflow edges. In this way, the separated fat and/or oil can rise into the collection pipe as the wastewater level in the separator tank increases, following the principle of differing densities. By utilizing this simple physical principle, both the separated fat and/or oil and the purified water can be discharged over their respective overflow edges through a simple structural design of the outlet and collection pipes.

Furthermore, the volume of the collection pipe is designed so that, at maximum filling level, the separated fat and/or oil is completely retained within the collection pipe. This allows the fat and/or oil to be stored in the collection pipe and subsequently discharged. This has the advantage that the collected fat and/or oil can be thoroughly and efficiently removed.

In another preferred embodiment, the separator tank is designed as a single-chamber tank, into which the inlet system, the outlet pipe, and the collection pipe

each discharge. The advantage of this embodiment is that it ensures a structurally very simple and functionally reliable configuration for the separation of fat and/or oil and water.

In a preferred embodiment, the separator tank may be designed as a double-chamber tank with a first chamber and a second chamber, wherein the inlet system discharges into the first chamber, and the outlet pipe as well as the collection pipe each discharge into the second chamber. The first and second chambers are connected by at least one coalescence element, in particular a coalescence tube, in which the fat and/or oil droplets dispersed in the water merge into larger fat and/or oil droplets with greater buoyancy. In this way, the separation of the oil-water mixture occurs by means of the principle of gravity, combined with the physical processes of adsorption and coalescence. As a result, the fat and/or oil droplets present in the water join together to form larger droplets with increased buoyancy and rise upward into the collection pipe. This significantly improves the separation of fat and/or oil from the wastewater.

Furthermore, the two chambers may be separated by a cover plate that extends downward at an angle from the second inlet opening of the collection pipe. By means of the downward-sloping cover plate, fat and/or oil as well as coarse residues can be directed purposefully toward either the first or the second chamber.

In another preferred embodiment, the separator tank may include an air device. During operation, a layer of fat may form on the cover plate or inside the collection pipe, thereby reducing the cross-section of the collection pipe. The air device enables mechanical cleaning of the cover plate and the collection pipe. In this mechanical cleaning method, air bubbles of various sizes act as an air brush, loosening the deposits. The air then flows through the collection pipe out of the separator device. This air-cleaning method is extremely gentle on both the cover plate and the collection pipe, in contrast to other cleaning techniques. The cleaning process is also more environmentally friendly and safer, as it requires no use of chemicals. Another advantage is that the air-cleaning system is highly versatile in its application.

Preferably, the collection pipe has at least one circumferential heating film that is applied to the outer wall of the collection pipe in order to liquefy the separated

fat and oil. This particularly simple design prevents the solidification of animal fats and oils at low temperatures.

Furthermore, the heating film may preferably be detachably connected to the outer wall of the collection pipe. This offers the advantage that, through simple installation of the heating film on the outer wall of the collection pipe-such as by pressing, gluing, or clamping-the solidified fat and/or oil can be liquefied. It is also conceivable for the collection pipe to be completely covered with heating film in order to prevent heat loss to the surrounding environment.

Furthermore, the collection pipe may include a floating ball positioned, during operation, between the oil/fat layer and the water layer. The density of the floating ball lies between that of water and that of the fat and/or oil. When the air device is used, it is conceivable that an increased volume of air could cause the water layer to rise up to the second overflow edge and enter the fat container. In this case, the floating ball rises to the upper section of the collection pipe and seals it. This makes it possible to temporarily close the collection pipe by means of a simple structural component, thereby preventing the undesired discharge of wastewater into the fat container.

Advantageously, the distance d between the two overflow edges is at least about 25 mm. A vertical distance d of at least approximately 25 mm ensures reliable separation of fat and/or oil, as described in the present application. In this way, it can be prevented that, at maximum wastewater inflow rate Q , the wastewater rises in the separator tank to a level where it reaches the fat container. By utilizing the simple physical principle of communicating vessels, fats and/or oils can be retained effectively through the separation of the water surfaces.

The invention is explained in greater detail below with reference to the accompanying schematic drawings.

In these drawings:

Fig. 1 shows a sectional view of a separator device according to a preferred embodiment of the invention;

Fig. 2 shows a sectional view of another separator device according to a further embodiment of the invention;

Fig. 3 shows a sectional view of yet another separator device according to an additional embodiment of the invention.

Fig. 1 shows an exemplary embodiment of a separator device 10 according to the invention. This embodiment illustrates the application of the separator device for the separation of oil, grease, or other residues from wastewater in facilities where wastewater containing grease is produced, in particular in kitchen operations and meat-processing plants. Other applications are also conceivable, for example, for the separation of oil, grease, or other residues at petrol stations.

The separator device 10 comprises a separator tank 11. Within the separator tank 11, the separation of fat and/or oil and other residues from wastewater takes place. The separator tank 11 is designed as a single-chamber tank for separating oil, grease, or other residues from wastewater. As shown in Fig. 1, the separator tank 11 may be of rectangular design, although other geometries of the separator tank 11 are also conceivable.

Furthermore, the separator tank 11 includes an inlet system 12, in particular with an inlet pipe 13, which is designed for the maximum wastewater inflow rate Q into the separator tank 11. The separator tank 11 also has an outlet pipe 14 for the purified wastewater, featuring a first inlet opening 15 and a first outlet opening 16. The outlet pipe 14 can be connected to a piping system, such as a sewer network. In the example shown in Fig. 1, the outlet pipe 14 is constructed as a cylindrical pressure pipe. Other forms of the outlet pipe are also possible.

Furthermore, the separator tank 11 includes a collection pipe 17 for the separated fat and/or oil, featuring a second inlet opening 18 and a second outlet opening 19. As shown in Fig. 1, the collection pipe 17 is made of a rigid material. The collection pipe 17 may be manufactured from a dimensionally stable material, in particular stainless steel, to ensure good heat transfer. Other materials that do not have any adverse effects on water are also conceivable.

The fat and/or oil rises within the wastewater and forms a fat and/or oil layer inside the collection pipe 17. The first outlet opening 16 forms a first, particularly horizontal overflow edge 20, over which the purified wastewater flows during operation. The second outlet opening 19 forms a second, particularly horizontal overflow edge 21, over which the separated oil and/or fat flows during operation, with the second overflow edge 21 positioned higher than the first overflow edge 20. Such an arrangement of the two overflow edges 20 and 21 prevents the water from entering the fat container, while at the same time, during operation at maximum wastewater inflow rate Q , ensuring reliable separation of fat and/or oil and water within the separator tank 11.

The overflow edges 20 and 21 have a rectangular edge shape. Other edge shapes for forming the overflow edges are also possible. Furthermore, a vertical distance d is provided between the two overflow edges 20 and 21.

During operation, at maximum wastewater inflow rate Q , an overflow height d_0 forms in the vertical direction at the first overflow edge 20. For reliable separation of fat and/or oil, both the vertical distance d and the overflow height d_0 are crucial. It has been shown that when $d \leq d_0$, the wastewater advances up to and flows over the second overflow edge 21, causing water to enter the fat container. To prevent the discharge of wastewater into the fat container, the lower limit of d is determined using the overflow height d_0 , according to: $d \geq 1.1 * d_0$. In particular, d may be: $d \geq 1.3 * d_0$, $d \geq 1.5 * d_0$, $d \geq 2.0 * d_0$, $d \geq 2.5 * d_0$, $d \geq 3.0 * d_0$, $d \geq 3.5 * d_0$, $d \geq 4.0 * d_0$, $d \geq 4.5 * d_0$, and in particular, $d \geq 5.0 * d_0$.

A vertically selected distance d determined in this manner has proven to be particularly efficient in ensuring reliable separation within the separator tank 11.

Preferably, the distance d between the two overflow edges 20 and 21 is at least approximately 25 mm.

The separator device 10 shown in Fig. 2 is identical to the separator device 10 in Fig. 1, except that it is designed as a double-chamber tank with a first chamber 22 and a second chamber 23, a cover plate 25, and a coalescence element 24.

Reference is therefore made to the foregoing description. The features and functions described in that context are likewise disclosed and claimed in connection with Fig. 2.

In Fig. 2, the separator device 10 comprises a separator tank 11. The separator tank 11 is designed in Fig. 2 as a double-chamber tank for the separation of oil, grease, or other residues from wastewater. The wastewater may contain coarse and fine solids, such as sludge, as well as floating liquids like oil and/or grease. In this specific case, the first chamber 22 serves to collect coarse and fine solids, such as sludge. The coarse and fine particles contained in the wastewater settle in the separator tank 11 and form a sludge layer. In the second chamber 23, the fat and/or oil rises into the collection pipe 17 and forms an oil and/or grease layer inside the collection pipe 17.

According to Fig. 2, the inlet system 12 discharges into the first chamber 22 of the separator tank 11. The outlet pipe 14 and the collection pipe 17 each discharge into the second chamber 23 of the separator tank 11.

The first chamber 22 and the second chamber 23 are fluidly connected by at least one coalescence element 24, in particular a coalescence tube. The coalescence element 24 can be configured in various ways. For instance, it may be provided with openings, holes, or similar structures. Other variants for achieving coalescence, such as plates, are also conceivable.

The two chambers 22 and 23 are separated by a cover plate 25. The cover plate 25 extends downward at an angle from the second inlet opening 18 of the collection pipe 17. The cover plate 25 serves to provide spatial separation between the chambers 22 and 23.

The separator device 10 shown in Fig. 3 is identical to the separator device 10 in Fig. 2, except that it additionally includes an air device 26, a heating film 27, and a floating ball. Reference is therefore made to the foregoing description. The features and functions described in that context are likewise disclosed and claimed in connection with Fig. 3.

In Fig. 3, the separator tank 11 includes an air device 26. In this specific case, the air device 26 is used for the mechanical cleaning of the cover plate 25 and the collection pipe 17. The air flows through the collection pipe and exits the separator device.

Furthermore, Fig. 3 also shows that the collection pipe 17 has at least one circumferential heating film 27, which is detachably connected to the outer wall of the collection pipe 17. In Fig. 3, the heating film 27 is shown as being fully attached to the outer wall of the collection pipe 17. It is also conceivable that the collection pipe 17 may be provided with the heating film 27 either completely or only partially.

Furthermore, during operation, the collection pipe 17 includes a floating ball 28 positioned between the oil/fat layer and the water layer. In Fig. 3, the floating ball 28 is shown as being made of plastic. Other objects with a density lower than that of water can also be used as the floating ball 28.

List of Reference Signs

10	Separator device
11	Separator tank
12	Inlet system
13	Inlet pipe
14	Outlet pipe
15	First inlet opening
16	First outlet opening
17	Collection pipe
18	Second inlet opening
19	Second outlet opening
20	First overflow edge
21	Second overflow edge
22	First chamber
23	Second chamber
24	Coalescence element
25	Cover plate
26	Air device

- 27 Heating film
- 28 Floating ball

Claims

1. Separator device (10) for separating oil, grease, or other residues from wastewater, comprising:
 - a separator tank (11),
 - an inlet system (12), in particular an inlet pipe (13), which is designed for a maximum wastewater inflow rate Q into the separator tank (11),
 - an outlet pipe (14) for purified wastewater, having a first inlet opening (15) and a first outlet opening (16), and
 - a collection pipe (17) for the separated oil and/or grease, having a second inlet opening (18) and a second outlet opening (19),characterized in that the first outlet opening (16) forms a first, in particular horizontal, overflow edge (20) over which the purified wastewater flows during operation, and the second outlet opening (19) forms a second, in particular horizontal, overflow edge (21) over which the separated oil and/or grease flows during operation, wherein
 - the second overflow edge (21) is positioned higher than the first overflow edge (20),
 - a vertical distance d is formed between the two overflow edges (20, 21), and
 - during operation, an overflow height d_0 of the purified wastewater forms at the first overflow edge (20) in the vertical direction at the maximum wastewater inflow rate Q ,wherein the following applies: $d \geq \text{essentially } 1.1 * d_0$.
2. Separator device (10) according to claim 1, characterized in that the vertical distance d is, in particular, $d \geq 1.3 * d_0$, preferably $d \geq 1.5 * d_0$, $d \geq 2.0 * d_0$, $d \geq 2.5 * d_0$, $d \geq 3.0 * d_0$, $d \geq 3.5 * d_0$, $d \geq 4.0 * d_0$, $d \geq 4.5 * d_0$, and in particular $d \geq 5.0 * d_0$.
3. Separator device (10) according to claim 1, characterized in that

the outlet pipe (14) and the collection pipe (17) are arranged vertically, at least in the region of their respective overflow edges (20, 21).

4. Separator device (10) according to claim 1 or 3,
c h a r a c t e r i z e d i n t h a t
the volume of the collection pipe (17) is designed such that, at maximum filling level, the separated fat and/or oil is completely retained within the collection pipe (17).
5. Separator device (10) according to any one of the preceding claims,
c h a r a c t e r i z e d i n t h a t
the separator tank (11) is designed as a single-chamber tank, into which the inlet system (12), the outlet pipe (14), and the collection pipe (17) each discharge.
6. Separator device (10) according to any one of the preceding claims,
c h a r a c t e r i z e d i n t h a t
the separator tank (11) is designed as a double-chamber tank having a first chamber (22) and a second chamber (23), wherein the inlet system (12) discharges into the first chamber (22), and the outlet pipe (14) as well as the collection pipe (17) each discharge into the second chamber (23), the first and second chambers (22, 23) being fluidly connected by at least one coalescence element (24), in particular a coalescence tube, in which fat and/or oil droplets dispersed in the water merge into larger fat and/or oil droplets with greater buoyancy.
7. Separator device (10) for separation according to claim 6,
c h a r a c t e r i z e d i n t h a t
the two chambers (22, 23) are separated by a cover plate (25), which extends downward at an angle from the second inlet opening (18) of the collection pipe (17).
8. Separator device (10) according to any one of the preceding claims,
c h a r a c t e r i z e d i n t h a t
the separator tank (11) includes an air device (26) for cleaning the inclined cover plate (25) and the collection pipe (17).

9. Separator device (10) according to any one of the preceding claims,
c h a r a c t e r i z e d i n t h a t
the collection pipe (17) comprises at least one circumferential heating
film (27) applied to the outer wall of the collection pipe (17) in order to
liquefy the separated fat and oil.
10. Separator device (10) according to claim 9,
c h a r a c t e r i z e d i n t h a t
the heating film (27) is detachably connected to the outer wall of the
collection pipe (17).
11. Separator device (10) for separation according to any one of the
preceding claims,
c h a r a c t e r i z e d i n t h a t
the collection pipe (17) includes, during operation, a floating ball (28)
arranged between the oil/fat layer and the water layer.
12. Separator device (10) according to claim 11,
c h a r a c t e r i z e d i n t h a t
the floating ball (28) is movable within the collection pipe (17) and, at a
high water level, rises to the upper section of the collection pipe (17),
thereby temporarily sealing the collection pipe (17).
13. Separator device (10) according to any one of the preceding claims,
c h a r a c t e r i z e d i n t h a t
the distance d between the two overflow edges (20, 21) is at least
approximately 25 mm.