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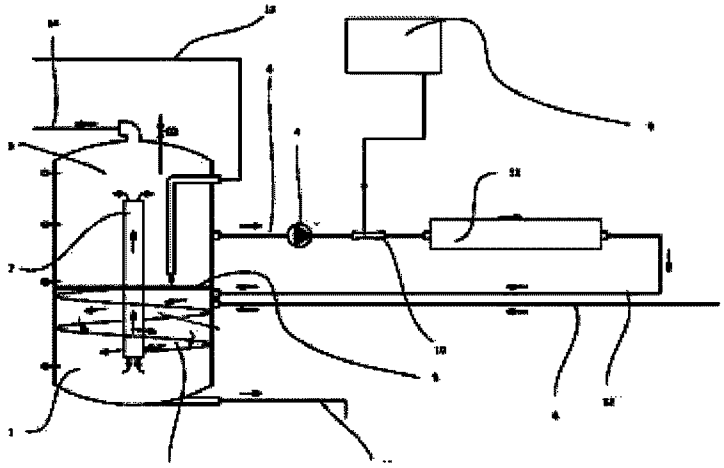
(54) Title **SYSTEM AND METHOD FOR TREATING AND RECYCLING OF WASTE WATER**

(57) Abstract

The invention relates to a system and a method for treating and recycling waste water from washing vehicles and the similar. The system is comprising a cylindrical sedimentation tank 1 and a cylindrical tank 3 for flotation and storage downstream of the sedimentation tank 1 wherein water to be treated is added to an inlet 6 at the upper end of the sedimentation tank 1, and treated water to be recycled is removed from an outlet 13 at the lower end of the flotation tank 3. The sedimentation tank 1 comprises a screw 2 having a major diameter similar to the inner diameter of the sedimentation tank, which forces the water to flow rotationally from the top towards the bottom of the sedimentation tank. Further, a riser 7 is arranged between the sedimentation tank 1and the flotation tank 3, at the centre of the screw 2. One end of the riser is close to a lower end of the screw in the sedimentation tank, and the other end is at an upper part of the flotation tank. A cleaning loop is arranged between the tanks, removing water from the flotation tank 3 and returning it to the sedimentation tank 1, wherein ozone is added to the loop.



TITLE: System and method for treating and recycling of waste water

Field of the invention

The present invention relates to a system for treating and recycling of waste water, preferably waste water from car wash plants, and a method for treating and recycling waste water according to the preamble of the independent claims.

Background of the invention

Several hundred litres of water is needed to wash a car, and often also a lot of chemicals. Even more water is needed to wash a trailer, truck or the similar, and the water may be expensive, in some areas the access to water may be limited, and thus the water should preferably be recycled within the plant. The water needs to be purified before it is used again, and sand and other particles must be removed, or they may cause damage to the car when the water is recycled.

The traditional way of treating and possibly recycling the waste water within a plant is by using sand traps, sludge treatment tanks and chemicals. Such treatment requires a lot of space, and the time needed before the water may be used again is several hours. Even when such a plant is working optimal, the water will be too dirty to be used after a few cycles, and it will smell and contain too many bacteria. Thus, the water needs to be treated further or replaced.

It is tried to use ozone to treat the water in order to reduce the amount of bacteria, and lower the time needed to recycle the water. Such plants are for instance described in WO 2009/135249 and US 2008/002347. However, the plants comprise several tanks and steps in order to purify the water, and thus the recycling time will be high.

Objects of the present invention

The main object of the invention is to provide a new method and system for purifying and recycling water, wherein the system should recycle the main share of the water. Another object is that the time needed to recycle the water should be sufficiently short to keep or increase the washing capacity of the system yet reducing the necessary space compared to known systems. Another object is that the water should be sufficiently purified to be used several times, and the system to purify the water should be easy to maintain and clean. Yet another object is that the close down of the system due to maintenance and service should be reduced compared to systems of prior art.

Summary of the invention

The objects above are met by a system and a method according to the characterizing part of the independent claims. Further features are stated in the corresponding dependent claims.

A system according to the present invention, for treating and recycling waste water from washing vehicles and the similar, comprises a cylindrical sedimentation tank and a cylindrical tank for flotation and storage downstream of the sedimentation tank, wherein water to be treated is flowing into an inlet at an upper part of the sedimentation tank, and water to be recycled is removed from an outlet at a lower part of the flotation tank. The sedimentation tank comprises a screw having a major diameter similar to the inner diameter of the sedimentation tank, which forces the water to flow rotationally from the top towards the bottom of the sedimentation tank. A riser is arranged between the sedimentation tank and the flotation tank, at the centre of the screw, one end of the riser is close to the lower end of the screw in the sedimentation tank, and the other end is in the upper part of the flotation tank. A cleaning loop is arranged between the tanks, removing water from the flotation tank and returning the water to the sedimentation tank, wherein ozone is added to the loop.

Preferably, the screw in the sedimentation tank has an even shank with a helical thread along its whole length. The crest of the screw threads is preferably bearing

against the inside of the sedimentation tank, and more preferably the opening between the crest of the threads and the inside of the tank is sealed. In this way the water entering the inlet at the upper part of the sedimentation tank, will be forced to flow on the threads of the screw, and thus a rotational flow is achieved.

The thread angle and the distance between the root and the crest of the threads may vary depending on the type and amount of water to be treated, and the size and design of the sedimentation tank. Further, the upper end of the screw should be as close as possible to the inlet of the tank, and the lower end should be close to the bottom of the tank but yet in a distance from the bottom, to allow any sediment at the bottom to settle. The screw is preferably stationary in the sedimentation tank, meaning that it does not move in relation to the sedimentation tank, and does not rotate.

The inlet to the system is in the upper part, preferably in the upper part of a wall of the sedimentation tank, and any water flowing through the inlet will be led onto the threads of the screw. The outlet of the system is in the lower part of the flotation tank. The outlet should be close to, but not in the bottom of the tank, in such a way that if any sediments settle in the flotation tank, these will not be flowing into the outlet. The positioning of the outlet will be obvious to a person skilled in the art.

By "riser" it is herein meant a pipeline arranged in such a way that water will flow upwards against gravitation, when sufficiently water is added to the system. When water is added to the inlet of the sedimentation tank, the water at the bottom will be forced to flow upwards and into the riser. In the present invention a riser is preferably arranged at the centre of the screw, meaning that the outside of the riser is the shank of the screw.

The riser is arranged from the lower end of the screw in the sedimentation tank to an upper part of the flotation tank. The outlet of the riser should be underneath the water line when the system is running, as the water flowing out of the riser preferably should not be exposed to air, to avoid excessive foaming in the flotation tank.

The distance from the bottom of the sedimentation tank to the inlet of the riser, and the distance from the outlet of the riser to the water line will vary with the flow rate, which is obvious to a person skilled in the art.

In the cleaning loop arranged between the sedimentation and flotation tank, ozone is added to disinfect the water. The addition of ozone will create small bubbles and the water, possibly containing chemicals, may foam. Ozone is preferably added through an injector which promotes foaming by causing turbulent flow in the cleaning loop, and thus a mixture of water, bubbles and foam will enter the sedimentation tank.

In a more preferred embodiment, the cleaning loop comprises a tank for homogenizing the foam, after the addition of ozone. The tank should be designed for pressure release and pressure increase, as this will homogenize and preferably minimize the bubbles, and foam having small bubbles of equal shape will be created. The foam will facilitate the removal of particles in the water by flotation, but it is preferred that the foam and bubbles are flowing with the water until it enters the flotation tank, and that flotation only occurs in the flotation tank. This is achieved by creating each bubble sufficiently small.

When foam and bubbles are covering the surface of the water in the flotation tank, they will prevent degassing of the water. Further, when the upper end of the riser is below the water line, degassing of the water added to the flotation tank will be prevented. The ozone dissolved in the water will thus retain in the water longer, and the effect of the ozone will be improved. When the system is running, the water line in the flotation tank must be in the upper part, above the outlet of the riser, but yet leaving sufficiently space for foam and bubbles to avoid degassing and to achieve flotation and removal of small particles.

The flotation tank should have an outlet to remove any foam and flotation sludge from the top of the flotation tank, and the sedimentation tank should be designed in order to remove any sediment from the bottom. This may be performed in many

ways which is obvious to a person skilled in the art, and is thus not described any further here.

In an alternative embodiment, the flotation tank may be filled partly or in whole with a packing material, to promote flotation. In the same way, the surface of the threads of the screw in the sedimentation tank may be covered with a material promoting sedimentation. Both these materials are well known in the art, and it will be obvious to a person skilled in the art to find the suitable materials.

In a preferred embodiment, the riser enters the bottom of the flotation tank and is arranged in the centre, having the outlet centred in an upper part, under the water line as described above. In a more preferred embodiment, the flotation tank is arranged directly above the sedimentation tank, and thus the riser is straight. In an even more preferred embodiment, the flotation tank is an upper part, and the sedimentation tank is a lower part of the same container, the tanks are separated by a water proof seal. This arrangement may be space saving.

There might be some times that no vehicles are washed, and thus no water to be treated is added to the system. Then the system is still running, but at slower rate, as the only water removed from the flotation tank is running into the cleaning loop, and the only water added to the sedimentation tank is from the cleaning loop. The flotation tank is therefore also the storage tank before the water is recycled.

In a preferred embodiment the water to be treated and recycled is led through an oil/silt separator before it enters the system according to the present invention.

The invention also comprises a method for treating and recycling waste water from washing vehicles and the similar in a washing area, using a system according to the invention. The method comprises the following steps:

- collecting water from the washing area,
- transferring water to the sedimentation tank,

- allowing the water to rotate in the sedimentation tank, and any particles of the water to settle,

- allowing the water to rise in the riser, and flow out into an upper part of the flotation tank,

- transferring a part of the water from the flotation tank to the cleaning loop, adding ozone to the water in the loop, and returning the water to the upper part of the sedimentation tank,

- transferring water from the bottom of the flotation tank to the washing area.

The method may also comprise a step for allowing the water to foam in a foaming tank, after the ozone is added to the cleaning loop.

The method may also comprise a step for collecting the water in an oil and silt separator.

Description of the figure

The invention will now be described with the help of the enclosed Figure 1, showing a flow diagram of a system for treating and recycling waste water according to the present invention. The different parts of the figure are not necessarily in scale to each other, as the diagram is merely for illustrating the invention.

The following description of an exemplary embodiment refers to the drawing, and the following detailed description is not meant or intended to limit the invention. Instead, the scope of the invention is defined by the appended claims.

Reference throughout the specification to “one embodiment” or “an embodiment” means that a particular feature, structure, or characteristic described in connection with an embodiment is included in at least one embodiment of the subject matter disclosed. Thus, the appearance of the phrases “in one embodiment” or “in an embodiment” in various places throughout the specification is not necessarily referring to the same embodiment. Further, the particular features, structures or

characteristics may be combined in any suitable manner in one or more embodiments.

The shown system comprises a sedimentation tank 1 having an internal screw 2 , a flotation tank 3, a pump 4 to circulate the water, and a cleaning loop wherein ozone is added. The sedimentation tank 1 and flotation tank 3 are arranged as lower and upper parts of the same container, separated by a floor 5, welded to the inside of the container. The flow of the water is indicated by arrows on the Figure.

The water is pumped from the washing area (not shown) to the sedimentation tank 1 through an inlet pipe 6. The water contains particles, sludge and sediments and is led into the tank tangentially at low speed, and flows onto the threads of the screw 2.

At a distance from the bottom of the sedimentation tank 1, it is shown a riser 7 running through the centre of the screw 2, leading the water to the flotation tank 3. The upper end of the riser, being the outlet, is in the upper part of the flotation tank 3 and when the system is running, the water line should be above the outlet of the riser.

A part of the water is removed from the flotation tank in a cleaning pipeline 8, and led into a cleaning loop, by an injector pump 4 which also circulates the water. Ozone is produced at site of an ozone generator 9 produced from oxygen in the air, and continuously added to the loop via an appropriate injector 10.

The waste water from the washing area contains a large amount of chemicals and particles, and will foam strongly. In order to homogenize the foam it is used a foaming tank 11 using a combination of speed-change and dynamic pressure fall and pressure rise to stabilize the bubbles of the water and give a nearly similar size of the bubbles. In the shown embodiment it is used a tank 11 having square ends, and once the water flows into the tank the pressure will release and bubbles will arise. When the water flows out of the tank, the pressure will rise again, and this will

reduce and homogenize the size of the bubbles. Other tanks or reactors giving the same result may also be used, which will be obvious to a person skilled in the art.

The water in the cleaning loop, treated with ozone and containing bobbles, are flowing back into the sedimentation tank in a cleaning return pipeline 12. The bubbles are an important part of the cleaning process as they transport particles and pollution by flotation, but also as they trap the ozone inside the water for optimal blending and contact period.

When the foaming water enters the sedimentation tank 1 and rotates at low speed, the bubbles will flow with the water, and enter the riser 7 to the flotation tank 3. When the water and foam flows out of the outlet of the riser, the foam and bubbles will rise and give foam on the surface. As the outlet is below the water line, excess foaming will be avoided.

Water is recycled to the washing area in return pipe 13, by removing water from the bottom of the flotation tank.

In the shown embodiment, the sedimentation tank has one level switch, and the flotation tank has three. These are used to ensure the correct water level of the tanks, give signals when sediments and/or sludge must be removed etc. The number and location of the level switches may vary.

The foam on the surface of the flotation tank has entrapped pollution and will be removed at the top of the tank through the sludge pipeline 14. Any sediments at the bottom of the sedimentation tank will be removed by the sedimentation pipeline 15.

When treating and recycling waste water using a system a shown in the Figure, the method comprises the following steps:

- collecting water from the washing area,
- pumping water to the sedimentation tank 1, through the inlet pipe 6,

- allowing the water to rotate on the threads of the screw 2 in the sedimentation tank, and any particles of the water to settle,

- allowing the water to rise in the riser 7, and flow out of the riser, under the water line in the flotation tank 3,

- pumping a part of the water from the flotation tank 3 to the cleaning loop, in the cleaning pipeline 8, producing ozone by the ozone generator 9 and adding ozone to cleaning pipeline with an injector 10, allowing the water and ozone to create foam in the foaming tank 11, and returning the water to the upper part of the sedimentation tank in the cleaning return pipe 12,

- transferring water from the bottom of the flotation tank to the washing area in the return pipe 13.

By the system and method according to the present invention, one achieves cleaner water by four methods:

A) An amount of ozone is added to the water to kill bacteria, virus, cysts and algae. The amount is adjusted to correspond to the water quality from the washing area. BOF, COF and turbidity is reduced. The miscolour of the water will also be reduced, as ozone has a bleaching effect.

B) Large amounts of dissolved oxygen is added to the water with the ozone. This will give "renewed life" to the water, and the sulphurous smell associated to old stagnant water will disappear.

C) By foaming the water, tiny particles and other pollutions being too small to sediment, will be removed as they attach to the small bobbles and are lifted out of the water by flotation.

D) Ozone has the effect that it releases molecules being attached to each other. Among the water molecules there will be large amounts of salts and minerals being chemically bound to each other, and which may not be filtered off or dissolved by

means of disinfectant or other chemicals. By using ozone these will be released and the result will be clearer water and more predictable chemistry.

The shown system is dimensioned for a plant cleaning 100 busses per day, being about 5 busses per hour. The sedimentation and flotation tank contains totally 2000 l water, and the amount of water needed to wash one buss is about 650 litre, being about 3250 l per hour. The pump for circulating the water is dimensioned to 6000 l/hour.

Ozone is produced and added at a rate of 18-36 gram per hour upon 10 % concentration. The amount of ozone needed seems to vary both with time of the year and weather, but also with the amount and type of cleaning chemicals being used. Samples of the recycled water should be taken to adjust the amount of added ozone regularly. The retention time in the system is about 36 minutes when the plant is running at full speed, and the number of cleaning cycles is about 3 per hour.

By using a method and a system according to the present invention, 70-80 % of the water being used for a car wash may be recirculated, which means that only ca 140 l water is removed and replaced from the system per wash. The water being removed is mainly water being left on the vehicles as they leave the plant, or evaporated water, and the fresh water being added should preferably be added in the last flushing of the car.

When the plant is operating at a speed of 100 busses per day, about 51.000 litres water is saved per day, by using the system and method according to the present invention. Electrical power and the amount of chemicals needed are also reduced.

The example above is given to illustrate the invention and should not be used to interpret the following claims limiting. The scope of the invention is not limited by the example give above, but the following claims. Modifications and amendments of the invention, being obvious to a person skilled of the art, should also be included in the scope of the invention.

Claims

1. System for treating and recycling waste water from washing vehicles and the similar, comprising a cylindrical sedimentation tank (1) and a cylindrical tank (3) for flotation and storage downstream of the sedimentation tank (1) wherein water to be treated is added to an inlet (6) at the upper end of the sedimentation tank (1), and treated water to be recycled is removed from an outlet (13) at the lower end of the flotation tank (3),

- the sedimentation tank (1) comprises a screw (2) having a major diameter similar to the inner diameter of the sedimentation tank, which forces the water to flow rotationally from the top towards the bottom of the sedimentation tank,

- a riser (7) is arranged between the sedimentation tank (1) and the flotation tank (3), at the centre of the screw (2), one end of the riser is close to a lower end of the screw in the sedimentation tank, and the other end is at an upper part of the flotation tank, and

- a cleaning loop is arranged between the tanks, removing water from the flotation tank (3) and returning it to the sedimentation tank (1), wherein ozone is added to the loop.

2. System according to claim 1, wherein the crest of the screw threads are bearing against with the inside of the sedimentation tank, and preferably the opening between the crest of the threads and the inside of the tank is sealed.

3. System according to claim 1 or 2, wherein the riser (7) is entering the flotation tank (3) at the bottom, and running through the centre of the tank.

4. System according to any one of the preceding claims, **characterized** in that the ozone is added to the water in cleaning the loop by an injector (10).

5. System according to any one of the preceding claims, **characterized** in that a tank (11) for homogenizing foam, is arranged in the cleaning loop, after the addition of ozone.

6. System according to any one of the preceding claims, **characterized** in that foam and flotation sludge may be removed at the top of the flotation tank.

7. Method for treating and recycling of waste water from a washing area, using a system according to claim 1, **characterized** by comprising the following steps:

- collecting water from the washing area,
- transferring water to the sedimentation tank (1),
- allowing the water to rotate in the sedimentation tank (1), and any particles of the water to settle,
- allowing the water to rise in the riser (7), and flow out into the upper part of the flotation tank (3),
- transferring a part of the water from the flotation tank to the cleaning loop, adding ozone to the water in the loop, and returning the water to the upper part of the sedimentation tank (1),
- transferring water from a lower part of the flotation tank to the washing area.

8. Method according to claim 7, **characterized** by comprising a step for allowing the water to foam in a foam reactor (11), after the ozone is added to the cleaning loop.

9. Method according to claim 7 or 8, **characterized** in that the water is collected in an oil and silt separator, before it is transferred to the sedimentation tank.

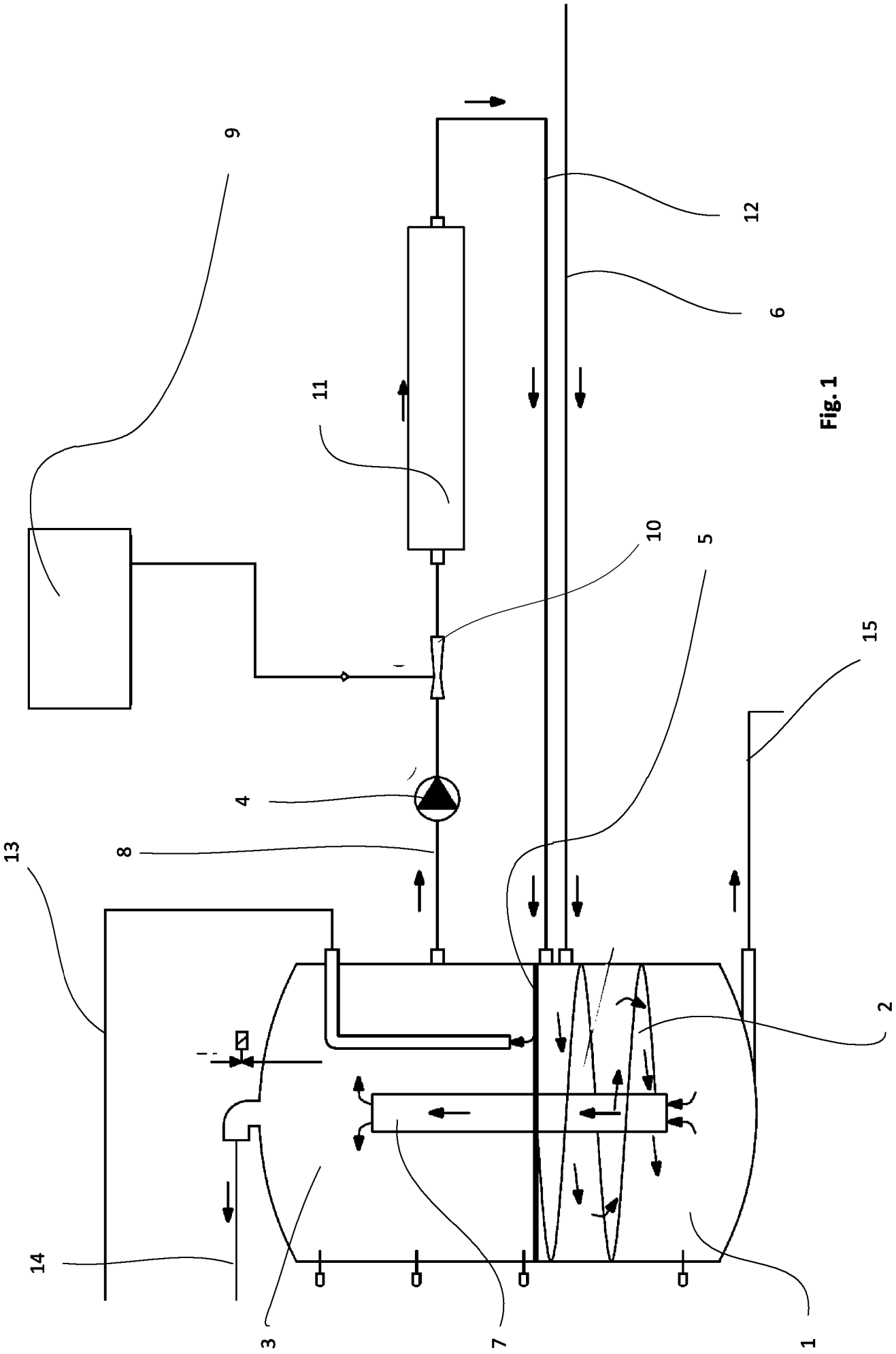


Fig. 1