METHOD AND APPARATUS FOR ENHANCING HIGH RATE WATER TREATMENT PLANT PERFORMANCE, IN PARTICULAR WITH THE USE OF FLOW STEERING FINS

TECHNICAL FIELD

[0001] The present invention generally relates to the purification of polluted and/or wastewater and more particularly to a method and apparatus for improving the flow inside the flock channel in order to separate liquid effluents from wastewater containing pollutant particles in a suspension. The present invention may also be applied to the instance of purifying seawater as may be required during the pre-desalination process.

BACKGROUND OF THE INVENTION AND DESCRIPTION OF RELATED AND/OR PRIOR ART

[0002] In many developing countries, there is certainly a growing demand for clean water, but also an increasing awareness of the need to stop contaminating their sources of water and the possibility of obtaining clean water from wastewater and/or polluted water. Further, many industries in these developing countries are more conscious that wastewater may be purified and reused to avoid penalties and/or sanctions or even simply to be more cost-effective, whereas many communities are now more interested in developing ways to treat water efficiently. A simple way to purify water is to treat them in a high rate treatment plant without the use of any chemicals, but which utilises the principles of coagulation and flocculation.

[0003] In order to clarify water in this way, it is necessary to form a flock. A flock is essentially clumps of bacteria and particulate impurities or coagulants that have come together and formed a cluster. Flocks are usually found in aeration tanks and secondary clarifiers. (*Alken-Murray Corp, Glossary of Environment and Microbiology Terms*, retrieved from http://www.alken-murray.com/glossarybug.html) This flock will then be separated from the liquid phase by settling. In order to form a flock, it is necessary to carry out coagulation first, before proceeding on to flocculation. Coagulation consists of the addition of a reactant, the coagulant, to enable the destabilisation of the colloidal particles present in the water and the neutralisation of all the electronegative charges on these particles. Subsequently, in the step of flocculation, these flocks are then enlarged. Here, a flocculation aid (usually polymer or generally synthetic polymer) is often injected in order to make the flocks larger and denser. In order to be physically separated from the water by settling (at the later sedimentation stage), a flock must be dense and preferably

of large size. (*John Bratby, Coagulation and Flocculation: with an emphasis on wastewater treatment*, 1980, Uplands Press Ltd)

[0004] Typically, in a high rate treatment plant, a plate settler is introduced to remove particulates from the liquids, and is positioned after the flock channel. If the flow leaving from the flock channel and enters into the plate settler is uneven and the high-speed flow is concentrated in any one area and especially just in one corner of the flock channel, there is a greater chance that the flock becomes unsettled. The flock that is then unsettled is likely to be broken up into smaller pieces before they are washed in with the supernatant liquid into the filtration stage. Such a situation is known as the “scouring effect”. As a result, the output of clean water in the water treatment process is lower and the process must be continued for several rounds which in turn increases the operating costs.

[0005] The difficulty with keeping the flock large to have a more efficient sedimentation process is due to the high possibility of turbulence and a turbulent flow in the sedimentation area. It is generally the case that the likelihood of the flow becoming turbulent in a high rate water treatment plant is two to four times higher than in a similar sized conventional water treatment plant. Therefore, it is envisaged that by reducing the tendency of a turbulent flow in the flocculation channel and thereby keeping it as laminar as possible instead, the water flow becomes equal (from the time it enters the high rate water treatment plant up till it enters the flocculation channel) and the flock that has been formed will not be broken to smaller parts. In this way, laminar flow will allow for the flock from the flock channel to enter the sedimentation process area without being broken or disintegrated.

[0006] There are clearly various water treatment methods being utilised in different ways to achieve different considerations. However, even in those where it is considered that keeping laminar flow would be an important aspect of increasing efficiency and achieving optimal outputs, none have been able to create an industrially and commercially viable solution.

[0007] In United States Patent No. 3728245, it is disclosed an apparatus and method for treating domestic and/or industrial waste water to render the same into a condition for either further reuse in industrial processing or for outflow into natural waters. The treatment utilises the principles of electrolysis to ionise the water utilizing the sodium of sodium chloride to form sodium hydroxide and the chloride as a bleaching agent. In particular, this prior art envisages that the flow of effluent through the sewage treatment apparatus as disclosed is kept substantially

laminar through the use of electrolysis “plates” installed in an alternating relation alongside other features and which thereby provide for relatively narrow flow passages. Although this invention considers the use of “plates” to also incidentally restrict the flow passages, it is not used on its own (since it is intended to cooperate with the spacers and the apetrures in the invention), and more importantly, such plates cannot be used in a high rate water treatment system.

[0008] On the other hand, in United States Patent No. 5589064, it is disclosed a method and apparatus for liquid solid separation of liquid effluents or wastewater containing pollutant particles in a suspension. In the sedimentation zone or clarification zone or “settler”, where it is free of turbulence (intended to create a settling and separation zone for settling of flocculent), the “settler” as disclosed is said to have inclined surfaces (at an angle of 30 degrees up to 60 degrees) meant to facilitate deposition of solids that have been separated from wastewater. In any event, the introduction of such a “settler” does not promote laminar flow, nor is the purpose of the same to control the flow in any way.

[0009] The concept or strategy of keeping the flow laminar is therefore not always the focus in water treatment processes, and in turn, improvements to water treatment plants and processes target different issues and have varying purposes.

SUMMARY OF THE INVENTION

[00010] The difficulty in ensuring that the water flow is distributed evenly into the sedimentation area from the flock channel shall be addressed and resolved in this invention. The present invention therefore provides the setting of water flow in the flock channel area as well as the sedimentation area with the use of fins that are strategically placed in the flock channel area. By introducing fins that can be tied, taped or even welded to the outlet of the flock channel area, this could potentially be a feasible solution to improve the performance of the water treatment process in a high-rate water treatment plant. By making the velocity of the water flow leaving the flock channel area as equal as possible, the water flow passing through the plate settler will be as close as possible as a laminar flow (i.e. having the same inflow speed when leaving the flock channel area into the sedimentation area).

[00011] The main advantage of this invention is therefore the high likelihood of minimising the process costs and yet keeping the productivity of the process high.

BRIEF DESCRIPTION OF THE DRAWING

[00012] Figure 1 is a process to illustrate generally the process involved in the high rate water treatment plant in this current invention.

[00013] Figure 2 is a representation of the sedimentation process area, and the fins that are positioned in the flock channel area.

[00014] Figure 3 is a representation of the fins and the matter that they may be placed at the flock channel area.

[00015] Figure 4 is a representation of the joining of the fin and the flock channel wall using a welding joint.

[00016] Figure 5 is a representation of the riveted joint for thin plate of fin and flock channel wall.

[00017] Figure 6 is a representation of the adhesive bonded joint for thin plate of fin and flock channel wall.

DETAILED DESCRIPTION OF THE DRAWING AND INVENTION

[00018] References will now be made in detail to the description of the present invention, an example of which is shown in figures. The example is provided to explain the invention and not a limitation. Accordingly, changes and modifications obvious to one skilled in the art to which the invention pertains are deemed to be within the spirit, scope and contemplation of the invention.

[00019] FIG. 1 provides an overview of the process involved in the current invention, wherein the fins **104** are introduced in one of the areas, namely the second area. Generally speaking, there are 4 areas which in turn, allow for 3 key stages to occur. The first is the “Coagulation-Flocculation Process Area” **102**, which allows for the polluted and/or wastewater (in which we refer to simply as “water” for convenience) **101** to enter the high rate water treatment plant and to go through the coagulation process first before going through the flocculation process

in the same area. A chemical reactant, the coagulant, is introduced to allow for the particles in such water **101** to combine together to form flocks. A flocculation aid (either a polymer or generally synthetic polymer) is also injected to make the flocks larger and denser. Once the flocks are formed, there is a “detention time” involved such that these flocks do not flow through along with the water to the next stage immediately. Detention time is essentially how much time the water **101** spends in the Coagulation-Flocculation Process Area **102**. This may also be understood to be the average length of time for the flock to be developed and enlarged. In this regard, the detention time is on an average around a minimum of 15 minutes at least, before moving towards the second stage accordingly.

[00020] The second key stage is the sedimentation process. Here, the “Sedimentation Process Area”-**103** is where the water and flock formed in the Coagulation-Flocculation Process Area **102** flow through and undergo the process of sedimentation. In this key stage, there are 2 areas that the water and the flock travel towards: (a) the flock channel area **103**; and (b) the plate settler area **105**. The third and last stage is the filtration stage and in which the water and the flock first enters the “Filtration Process Area” **106**. As the name suggests, the supernatant water (with as little flock therein as possible) would then be filtered so that only purified water would flow out as the desired output. The usual disinfection process towards the purified water may be resumed separately accordingly.

[00021] FIG. 2 focuses on the Sedimentation Process Area **106** more closely which illustrates the implementation of the key feature of the current invention. Generally, the water and flock are redirected from the Coagulation-Flocculation Process Area **102** to the flock channel area, and then steered through the same before moving and downwards through the passageway created by the fins **104**. Thereafter, said water and flock leave through the outlet of the flock channel area **201** before moving upwards to the plate settler area **105**. In the current invention, fins **104** are installed to allow the water flow velocity to be distributed evenly throughout the flock channel area **103** from the time the water flows through from the Coagulation-Flocculation Process Area **102** and into the Sedimentation Process Area **106**.

[00022] Surface loading is one of the most important factors affecting the effectiveness of the sedimentation process and the surface loading rate is used to determine if the sedimentation area is under or over loaded. The surface loading test calculates the volume of water being treated over a period of time, over the surface area of the sedimentation area.

Excessive surface loading values (i.e. overloading) may lead to the flocks being carried over to the next area in the treatment process, and this is what is referred to as the “scouring effect” as elaborated earlier. The surface loading in a conventional high rate water treatment plant tends to be in the range of 9 to 15 m/hour. However, in the current invention, the surface loading is in the range of 27 to 35 m/hour, which therefore allows for higher efficiency of the sedimentation processes.

[00023] At the plate settler area **105**, there are various plate settlers positioned therein. Here, the flocks are settled as sediment. The length of the plate settler in the preferred embodiment is around 2.4m although it can be of any length in reality, depending on the surface loading or capacity of the treatment plant. The more even the flow across the entire plate settler area **105** the more efficient the settling process is. Eventually, the supernatant liquid (i.e. the more purified water at this stage) goes through the requisite filtration process.

[00024] Given that a key feature of the current invention is the fins **104**, FIG. 3 is disclosed to show the fins **104** in greater detail, and the manner that they may be positioned in the water treatment plant. In the preferred embodiment, each fin **104** is inclined and this can be between 25 to 75 degrees, depending on the size of the Sedimentation Process Area **106** as well as the water treatment plant. The size of the fin **104** would vary depending on the size of said plant. Nevertheless, generally speaking, where H= the height of the flock channel area **103**, the smallest fin **104** would be around 10% of the length of H, and the biggest fin (**104**) would be around 85% of the length of H. In the preferred embodiment, the fins **104** are positioned evenly across the outlet of the flock channel area **201**. Nevertheless, it is envisaged that the fins **104** may be positioned in any manner or form. In the preferred embodiment as well, the number of fins **104** per flock channel area **103** is minimally 3, and would generally depend on the water coming into the flock channel area **103** in the Sedimentation Process Area **106**. However, it is envisaged that any number of fins could still produce the desired results with respect to the output volume of purified water, or even higher.

[00025] In the preferred embodiment, the fins **104** are made of stainless steel, but it is envisaged that any type of metallic material, polymeric material or composite material may be suitable. In the preferred embodiment as well, the fins **104** are welded to the wall in the flock channel area **103**. In the event that the material used for the fins **104** and for the flock channel wall **402** is the same type of metal (in sheet form), it is anticipated that the best way to join the

fins **104** to the flock channel wall **401** is by welding **402**, as per FIG. 4. If welding is used, then the minimum thickness is 0.8mm, although any length of thickness could still be acceptable.

[00026] In the other embodiments, the fins **104** and the flock channel wall **401** can be tied up using rivet joint **501**, as shown in FIG. 5. Alternatively, it is envisaged that the fin **104** and the flock channel wall **401** can also be connected by adhesive bonding **601** as shown in FIG. 6.

CLAIMS

We claim:-

1. A method of water purification by improving the flow in a flock channel area of a high rate water treatment plant comprising of the following steps:-

    allowing water to flow through a coagulation-flocculation process area to undergo the processes of coagulation with the help of a coagulant and flocculation with the help of a flocculation aid, and thereby forming a plurality of flocks within the water and in turn a mixture of water and flock;

    detaining the mixture of water and flock in the coagulation-flocculation process area for a minimum of 15 minutes on average;

    redirecting the mixture of water and flock to the start of a sedimentation process area;

    introducing even and equidistantly positioned fins across the outlet of the flock channel area and thereby distributing the water flow velocity evenly throughout the flock channel area;

    steering the mixture of water and flock through the flock channel area and downwards through a passageway created by said fins;

    allowing the mixture of water and flock to leave through the outlet of the flock channel area;

    continually redirecting the mixture of water and the remaining flock upwards to a plate settler area for settling to be done leading to a supernatant liquid to emerge on top and thereby completing the sedimentation process;

    enabling the supernatant liquid to move towards a filtration area for filtration process to occur;

    wherein out of the supernatant liquid that comes out of the filtration process is purified water that can be disinfected separately and immediately for further use.

2. The method of water purification by improving the flow in the flock channel area of a high rate water treatment plant of Claim 1, wherein said fins are at most 85% of the height of the flock channel area.

3. The method of water purification by improving the flow in the flock channel area of a high rate water treatment plant of Claim 2, wherein said fins are at least 10% of the height of the flock channel area.

4. The method of water purification by improving the flow in the flock channel area of a high rate water treatment plant of Claim 3, wherein said fins are being inclined to an angle between 25 to 75 degrees.

5. The method of water purification by improving the flow in the flock channel area of a high rate water treatment plant of Claim 4, wherein said fins are made of stainless steel.

6. The method of water purification by improving the flow in the flock channel area of a high rate water treatment plant of Claim 5, wherein there are at least 3 of said fins positioned in the flock channel area.

7. The method of water purification by improving the flow in the flock channel area of a high rate water treatment plant of Claim 6, wherein said fins are configured to the flock channel wall by welding.

8. The method of water purification by improving the flow in the flock channel area of a high rate water treatment plant of Claim 6, wherein said fins are configured to the flock channel wall by tying using a rivet joint.

9. The method of water purification by improving the flow in the flock channel area of a high rate water treatment plant of Claim 6, wherein said fins are configured to the flock channel wall by adhesive bonding.

10. A system for deriving purified water efficiently through the improvement of the flow in a flock channel area of a high rate water treatment plant comprising of:-

    a coagulation-flocculation process area for receiving water;

    a sedimentation process area further comprising of the flock channel area having a plurality of fins positioned evenly throughout the outlet of the flock channel area, and a plate settler area to settle all sediment within the water; and

    a filtration process area for receiving the water from the flock channel area before filtering out purified water;

    wherein the purified water can be disinfected separately and immediately for further use.

11. The system for deriving purified water efficiently through the improvement of the flow in the flock channel area of a high rate water treatment plant of Claim 10, wherein said fins are at most 85% of the height of the flock channel area.

12. The system for deriving purified water efficiently through the improvement of the flow in the flock channel area of a high rate water treatment plant of Claim 11, wherein said fins are at least 10% of the height of the flock channel area.

13. The system for deriving purified water efficiently through the improvement of the flow in the flock channel area of a high rate water treatment plant of Claim 12, wherein said fins are inclined between 25 to 75 degrees.

14. The system for deriving purified water efficiently through the improvement of the flow in the flock channel area of a high rate water treatment plant of Claim 13, wherein there are at least 3 of said fins positioned in the flock channel area.

15. The system for deriving purified water efficiently through the improvement of the flow in the flock channel area of a high rate water treatment plant of Claim 14, wherein said fins are made of stainless steel.

16. The system for deriving purified water efficiently through the improvement of the flow in the flock channel area of a high rate water treatment plant of Claim 15, wherein said fins are welded to the wall of the flock channel area.

17. The system for deriving purified water efficiently through the improvement of the flow in the flock channel area of a high rate water treatment plant of Claim 15, wherein said fins are tied to the wall of the flock channel area using a rivet joint.

18. The system for deriving purified water efficiently through the improvement of the flow in the flock channel area of a high rate water treatment plant of Claim 15, wherein said fins are connected to the wall of the flock channel area by adhesive bonding.