

CYCLONE SETTLING APPARATUS

BACKGROUND OF THE INVENTION

5 1. Field of the invention

The present invention relates to a cyclone settling apparatus, and more particularly to an apparatus for improving an existing cyclone settling apparatus for liquid-solid separation through settling to generate proper
10 vortices to strongly prevent destruction of flocs due to polluted water and accordingly effectively eliminate the flocs, thereby maximizing a filtering efficiency for the contaminated water.

15 2. Description of the Prior Art

As generally known in the art, settling apparatuses are widely used for eliminating foreign substances from polluted water (such as water for civil engineering) flowing out from various industrial fields and reproducing
20 the polluted water into fresh water.

FIG. 1 is a view showing a general settling apparatus. As shown in FIG. 1, in the general settling apparatus, as polluted water together with chemicals sequentially pass through an acidity adjusting tank 1, a reaction tank 2, and
25 a cohesion tank 3, the acidity of the polluted water is

properly adjusted, the reaction of the polluted water with the chemicals is promoted, and foreign substances (such as earth and sand, and suspensions in the water) are condensed.

5 Then, sludge produced through the condensing and settling can be collected and discharged by a scraper 5 at a lower portion of a settling tank 4, and fresh water at an upper portion of the settling tank 4 can be utilized.

 However, the conventional settling apparatus as
10 described above requires wide installation spaces for installing the settling tank, as well as the acidity adjusting tank, the reaction tank, and the cohesion tank, and consumes much time in filtering polluted water. Moreover, each tank requires of the conventional settling
15 apparatus a mixer driven by a motor. Therefore, the conventional settling apparatus itself needs to be large-scaled and consumes excessive installation and operation costs.

 In order to overcome the shortcomings of the above-
20 described typical settling apparatus, cyclone settling apparatuses are recently widely used.

 FIG. 2 is a schematic view showing a cyclone settling apparatus according to the related art. FIG. 3 is a perspective view of a drainage unit of the cyclone settling
25 apparatus according to the related art.

The cyclone settling apparatus according to the related art was registered with Korean Patent No. 0877309 whose patentee is the applicant of the present invention. As shown in FIGS. 2 and 3, the cyclone settling apparatus
5 includes: a body 10 which is shaped like a cylindrical tank and includes a high-speed nozzle 11 extending in a tangential direction thereof on an upper outer peripheral surface thereof to communicate therewith and a funnel-shaped sludge eliminating cone 12 formed at a lower portion
10 thereof; a water supply unit 20 which is connected to the high-speed nozzle 11 and includes inline mixers 21, 22, and 23 connected in series to each other in multi-stages according to inputted chemicals; and a drainage unit 30 including a porous pipe 31 vertically installed at a
15 central portion of the body 10, funnel-shaped multistage inclined cones 32 fixed to an outer peripheral surface of the porous pipe 31 to gradually expand downward, and panel-shaped vortex fins 33 radially arranged on upper surfaces of the inclined cones 32, for discharging fresh water to
20 the outside of the body 10.

As shown in FIG. 2, the cyclone settling apparatus configured as described above employs inline mixers 21, 22, and 23 having different diameters and lengths and a reaction promoting tank 24 according to the chemicals
25 inputted to polluted water, so as to efficiently treat a

large amount of polluted water in a short time and additionally generate secondary vortices by the vortex fins 33 in the inclined cones 32 after the basic generation of primary vortices in the body 10, thereby more effectively
5 separating foreign substances from the polluted water.

However, the plurality of vortex fins respectively formed in the multistage inclined cones employed by the cyclone settling apparatus according to the related art increases the manufacturing costs. Further, the general
10 cyclone settling apparatus other than the vortex fins is required to generate proper vortices to eliminate flocs without destructing the flocs, but it has no arranged size standards and thus has a limit in increasing the filtering efficiency.

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SUMMARY OF THE INVENTION

Accordingly, the present invention has been made to solve the above-mentioned problems occurring in the prior
20 art, and an object of the present invention is to provide a cyclone settling apparatus which can generate proper vortices to easily eliminate flocs while strongly preventing destruction of the flocs, thereby maximizing the filtering efficiency for polluted water.

25 In order to accomplish this object, there is provided

a cyclone settling apparatus including: a body which is shaped like a cylindrical tank and comprises a high speed nozzle extending in a tangential direction thereof on an upper outer peripheral surface thereof to communicated
5 therewith and a funnel-shaped floc eliminating cone formed at a lower portion thereof; a water supply unit which is connected to the high speed nozzle and comprises a mixer for mixing chemicals and polluted water to supply the chemicals-mixed polluted water into the body; and a
10 draining unit comprising a porous pipe vertically installed at a central portion of the body, funnel-shaped multistage inclined cones fixed to an outer peripheral surface of the porous pipe and gradually expanding downward, and an uppermost inclined cone for discharging fresh water to the
15 outside of the body unit, which is additionally provided above the multistage inclined cones and has a wall integrally extending downward from a lower outer periphery thereof so that the uppermost inclined cone surrounds upper and lateral sides of the multistage inclined cones.

20 The mixer of the water supply unit may include an inline mixer and a closed low-speed mixing tank.

 The multistage inclined cones and the uppermost inclined cone may have a same inclination angle. The inclined angle may be 45 to 60 degrees with respect to a
25 horizontal plane. The multistage inclined cones may

include 2 to 10 stages. A gap between an inner peripheral surface of the body and an outer peripheral surface of the wall of the uppermost inclined cone may be $0.02D$ to $0.2D$ (D : a diameter of the body). A gap between an inner
5 peripheral surface of the wall of the uppermost inclined cone and a lower outer periphery of the multistage inclined cones may be $0.02D$ to $0.2D$.

A height of the wall of the uppermost inclined cone may be $0.15D$ to $2.5D$, and a sediment draining hole having a
10 diameter of 0.02 to $0.2D$ may be formed at a lower end of the porous pipe of the body such that flocs are sunk and drained through the sediment draining hole.

According to the present invention, a cyclone settling apparatus can generate proper vortices to easily eliminate
15 flocs while strongly preventing destruction of the flocs, thereby maximizing the filtering efficiency for polluted water.

BRIEF DESCRIPTION OF THE DRAWINGS

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The above and other objects, features and advantages of the present invention will be more apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

25 FIG. 1 is a view showing a general settling apparatus;

FIG. 2 is a schematic side elevation showing a cyclone settling apparatus according to the related art;

FIG. 3 is a partly cut-out perspective view showing a drainage unit of the cyclone settling apparatus according to
5 the related art;

FIG. 4 is a schematic view showing a cyclone settling apparatus of the present invention;

FIG. 5 is a plan view showing the cyclone settling apparatus of the present invention;

10 FIG. 6 is a perspective view of a main part of the cyclone settling apparatus of the present invention; and

FIGS. 7 and 8 are diagrams showing numerical analysis results of the cyclone settling apparatus of the present invention.

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DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, a preferred embodiment of the present invention will be described with reference to the
20 accompanying drawings. In the following description and drawings, the same reference numerals are used to designate the same or similar components, and so repetition of the description on the same or similar components will be omitted.

25 FIG. 4 is a schematic view showing a cyclone settling

apparatus of the present invention. FIG. 5 is a plan view showing the cyclone settling apparatus of the present invention. FIG. 6 is a perspective view of a main part of the cyclone settling apparatus of the present invention.

5 As shown in FIGS. 4 to 6, the cyclone settling apparatus of the present invention includes: a body 100 which is shaped like a cylindrical tank and includes a high speed nozzle 110 extending in a tangential direction thereof on an upper outer peripheral surface thereof to
10 communicated therewith and a funnel-shaped floc eliminating cone 120 formed at a lower portion thereof; a water supply unit 200 which is connected to the high speed nozzle 110 and includes a mixer for mixing chemicals and polluted water to supply the chemicals-mixed polluted water into the
15 body 100; and a draining unit 300 including a porous pipe 310 vertically installed at a central portion of the body 100, funnel-shaped multistage inclined cones 320 fixed to an outer peripheral surface of the porous pipe 310 and gradually expanding downward, and an uppermost inclined
20 cone 330 for discharging fresh water to the outside of the body unit 100, which is additionally provided above the multistage inclined cones 320 and has a wall 331 integrally extending downward from a lower outer periphery thereof so that the uppermost inclined cone 330 surrounds upper and
25 lateral sides of the multistage inclined cones 330.

Hereinafter, an embodiment of the present invention will be described with reference to the accompanying drawings.

As shown in FIGS. 4 to 6, the cyclone settling
5 apparatus of the present invention according to the present invention includes a body 100, a water supply unit 200, and a drainage unit 300. In particular, a main characteristic of the present invention lies in the improvement of the drainage unit 300.

10 First, the body 100 corresponds to a vertically cylindrical tank. As shown in FIG. 5, a high-speed nozzle 110 is connected to an upper outer peripheral surface of the body 110, and in particular, the high-speed nozzle 110 is connected to an outer peripheral surface of the body 110
15 along a tangential direction of the body so that if polluted water is introduced into the body 100 through the high-speed nozzle 110, vortices are generated in an interior of the body 110 as indicated by arrows.

A funnel-shaped floc eliminating cone 120 whose
20 diameter gradually decreases downward is formed at a lower portion of the body 100, so that settled flocs are collected by the vortices generated in the body 100 and are then discharged to the outside when a predetermined amount of flocs have been accumulated in the floc eliminating cone
25 120.

Although not shown separately, a plurality of legs are formed on an outer surface of the body 100 so that the body 100 can be installed vertically, and a separate valve for discharging other floating matters such as oil to the
5 outside may be provided at an upper portion of the body 100.

Next, the water supply unit 200 is adapted to supply polluted water into the body 100 while generating vortices of polluted water therein, and the above-described high-speed nozzle 110 is connected to a distal end of the water
10 supply unit 200.

Then, the water supply unit 200 includes a mixer for evenly mixing chemicals and polluted water in a short time.

Here, the inputted chemicals refer to polymer conglomerates in the form of flocs produced through
15 condensation of foreign substances in the form of solid particles contained in polluted water, and conglomerates produced through condensation of particles with a size of 0.1 μm or larger are usually referred to as flocs.

In particular, in the present invention, it is
20 preferred that the mixer of the water supply unit 200 preferably includes an inline mixer 210 and a closed low-speed mixing tank 220.

First, the inline mixer 210 generally has a pipe shape. A panel, that is, a semi-elliptical panel is formed in
25 zigzags within the inline mixer 210, and an inlet for

introducing chemicals is formed at an intermediate portion of the inline mixer 210.

The closed low-speed mixing tank 220 has a shape of a separate closed tank as shown in FIG. 4 so that polluted
5 water and chemicals can be evenly mixed by rotary blades in the tank.

Finally, the drainage unit 300 includes a porous pipe 310, multistage inclined cones 320, and an uppermost inclined cone 330 to eliminate flocs from polluted water
10 and drain fresh water, from which flocks have been eliminated, to the outside of the body 100.

First, the porous pipe 310 is a vertical hollow pipe, and the multistage inclined cones 320 and the uppermost inclined cone 330 which are to be described below are
15 fixedly supported by an outer peripheral surface of the porous pipe 310 and circulation holes having a predetermined diameter are formed between the multistage inclined cones 320 on an outer peripheral surface of the porous pipe 310.

20 In particular, a pipeline for draining fresh water is formed at an upper opening of the porous pipe 310, and a sediment drainage hole 311 is formed at a downstream side of the porous pipe 310 so that if sunk flocs are drained downward through the sediment drainage hole 311, flocs
25 gather in the above-described floc eliminating cone 120.

A plurality of funnel-shaped multistage inclined cones 320 whose diameters gradually increase downward are fixedly formed vertically on an outer peripheral surface of the porous pipe 310 to be spaced apart from each other.

5 Then, although the number of the multistage inclined cones 320 is not specifically limited, around 2 to 10 multistage inclined cones 320 are preferable and FIG. 6 shows five multistage inclined cones 320 as an example.

 In particular, the uppermost inclined cone 330 is
10 additionally provided on the above-described multistage inclined cones 320 in the present invention.

 The uppermost inclined cone 330 has the same structure as that of the above-described inclined cones, and is formed on an outer peripheral surface of the porous pipe
15 310 to have a funnel shape whose diameter is gradually expanded downward. The upper most inclined cone 330 differs from the inclined cones in that a wall 331 is additionally formed integrally with a lower outer periphery thereof.

20 The wall 331 extends downward by a predetermined length, and accordingly, the uppermost inclined cone 330 having the wall 331 surrounds upper and lateral sides of the multistage inclined cones 320 on a lower side thereof.

 After performing experiments and numerical analyses
25 while variously changing the size of the cyclone settling

apparatus of the present invention, the applicant could identify that the most effective vortices in eliminating flocs from the body 100 are generated when the uppermost inclined cone 330 has the wall 331 surrounding the
5 multistage inclined cones 320 as described above.

In addition, in the present invention, the multistage inclined cones 320 and the uppermost inclined cones 330 have the same inclination angle, and the inclination angle achieves the most preferable result when it is 45 to 60
10 degrees with respect to a horizontal plane.

When a diameter of the body 100 is D , a gap between an inner peripheral surface of the body 100 and an outer peripheral surface of the wall 331 of the uppermost inclined cone 330 is preferably $0.02D$ to $0.2D$.

15 Further, a gap between an inner peripheral surface of the wall 331 of the uppermost inclined cone 330 and a lower outer periphery of the multistage inclined cone 320 is preferably $0.02D$ to $0.2D$.

In particular, in the present invention, a height of
20 the wall 331 of the uppermost inclined cone 330 is $0.15D$ to $2.5D$, and a sediment draining hole 311 having a diameter of $0.02D$ to $0.2D$ is preferably formed at a lower end of the porous pipe 310 of the body 100.

FIGS. 7 and 8 are diagrams showing numerical analysis
25 results of the cyclone settling apparatus of the present

invention. The applicant identified whether vortices are smoothly generated through a numerical analysis by modeling the cyclone settling apparatus such that the body 100 and the drainage unit 300 have the above-described sizes.

5 FIG. 7 is a speed diagram for the cyclone settling apparatus of the present invention, from which it can be seen that speeds of vortices range from a highest speed of 0.2 m/s indicated by a red color to a lowest speed of 0.0 m/s indicated by a blue color, resulting in the vortices
10 being smoothly formed in the body 100.

FIG. 8 was obtained by analyzing behaviors of flocs in the cyclone settling apparatus of the present invention, and it can be seen from FIG. 8 that when a concentration of flocs contained in introduced polluted water is 500 mg/L,
15 the high-concentration flocs introduced into the inclined cone cannot reach an upper end of the porous pipe 310 but descends through the sediment draining hole 311 to be stacked on the floc eliminating cone 120.

Hereinafter, an operation of the present invention
20 will be described with reference to FIGS. 4 to 6.

In the above-configured cyclone settling apparatus of the present invention, polluted water is supplied into the water supply unit 200 first.

In the water supply unit 200, the polluted water
25 passes through the mixer, that is, the inline mixer 210 and

the closed low-speed mixing tank 220, and then chemicals are inputted into the polluted water.

For example, the chemicals are polymers, and the inputted polymers react with earth and sand, and suspension
5 contained in the polluted water to condense foreign substances into coarse particles or flocs.

Thereafter, while the polluted water having passed through the water supply unit 200 is introduced into the body 100 through the high-speed nozzle 110 of the body 100,
10 the polluted water forms vortices in the body 100 and the flocs contained in the polluted water are sunk at a lower central portion of the body 100 to be discharged to the outside of the body 100 through the flock eliminating cone 120.

15 The polluted water rotated by the vortices formed in the body 100 as described above is introduced into the porous pipe 310 through gaps between the multistage inclined cones 320 formed in the drainage unit 300 and then is discharged to the outside of the body 100 through the
20 drainage unit 300.

Then, while the vortices of the polluted water are rapidly reduced on upper surfaces of the multistage inclined cones 320, the flocs contained in the polluted water roll down along the upper surfaces of the multistage
25 inclined cones 320, and are sunk onto the flock eliminating

cone 120 through the sediment draining hole 311 even in the porous pipe 310.

The grown flocs drop downward due to the simultaneous occurrence of the dynamic separation by the vortices and
5 the separation by the surface loading rate in the vortices, and the fluid rises toward the porous pipe 310 while gradually forming laminar flows. As a result, an effect of sinking the flocs in the polluted water can be further improved.

10 Thus, the cyclone settling apparatus of the present invention additionally employs the uppermost inclined cone 330 having the wall 331 such that the uppermost inclined cone 330 surrounds the multistage inclined cones 320, to generate optimum vortices for sinking flocs from the
15 polluted water, thereby maximizing a filtering efficiency for the polluted water.

The above-described embodiment is an example for describing the technical spirit of the present invention in detail, and the scope of the present invention is not
20 limited to the accompanying drawings and embodiment.

WHAT IS CLAIMED IS:

1. A cyclone settling apparatus comprising:

a body which is shaped like a cylindrical tank and
5 comprises a high speed nozzle extending in a tangential
direction thereof on an upper outer peripheral surface
thereof to communicated therewith and a funnel-shaped floc
eliminating cone formed at a lower portion thereof;

a water supply unit which is connected to the high
10 speed nozzle and comprises a mixer for mixing chemicals and
polluted water to supply the chemicals-mixed polluted water
into the body; and

a draining unit comprising a porous pipe vertically
installed at a central portion of the body, funnel-shaped
15 multistage inclined cones fixed to an outer peripheral
surface of the porous pipe and gradually expanding
downward, and an uppermost inclined cone for discharging
fresh water to the outside of the body unit, which is
additionally provided above the multistage inclined cones
20 and has a wall integrally extending downward from a lower
outer periphery thereof so that the uppermost inclined cone
surrounds upper and lateral sides of the multistage
inclined cones.

25 2. The cyclone settling apparatus as claimed in

claim 1, wherein the mixer of the water supply unit comprises an inline mixer and a closed low-speed mixing tank.

5 3. The cyclone settling apparatus as claimed in claim 2, wherein the multistage inclined cones and the uppermost inclined cone have a same inclination angle, the inclined angle is 45 to 60 degrees with respect to a horizontal plane, the multistage inclined cones comprise 2
10 to 10 stages, a gap between an inner peripheral surface of the body and an outer peripheral surface of the wall of the uppermost inclined cone is $0.02D$ to $0.2D$ (D : a diameter of the body), and a gap between an inner peripheral surface of the wall of the uppermost inclined cone and a lower outer
15 periphery of the multistage inclined cones is $0.02D$ to $0.2D$.

 4. The cyclone settling apparatus as claimed in claim 3, wherein a height of the wall of the uppermost
20 inclined cone is $0.15D$ to $2.5D$, and a sediment draining hole having a diameter of 0.02 to $0.2D$ is formed at a lower end of the porous pipe of the body such that flocs are sunk and drained through the sediment draining hole.