[CLAIMS]

[Claim 1]

A water treatment apparatus comprising:

a tilted plate disposed at an incline relative to a horizontal plane so that water to be treated flows over an upper surface thereof;

a discharge forming body that is disposed across a gas layer above a water film formed by the water to be treated flowing over the tilted plate; and

a droplet forming apparatus that treats the water to be treated by exerting power on the water film so that at least some of the water to be treated shoots up from the tilted plate in the form of droplets and the droplets come into contact with a discharge formed by the discharge forming body.

[Claim 2]

The water treatment apparatus according to claim 1, wherein the discharge forming body includes at least a pair of electrodes, and forms a discharge by applying a voltage between the electrodes.

[Claim 3]

The water treatment apparatus according to claim 1 or 2, wherein the water to be treated is treated by applying a voltage between the discharge forming body and the tilted plate in order to form a discharge, and bringing the water film into contact with the discharge.

[Claim 4]

The water treatment apparatus according to any one of claims 1 to 3, wherein a plurality of water treatment units, each including

the tilted plate and the discharge forming body, are disposed so as to be arranged in a vertical direction, and

the respective tilted plates are tilted in alternating opposite directions relative to the horizontal plane so that the water to be treated flows continuously downward from an uppermost water treatment unit to a lowermost water treatment unit.

[Claim 5]

The water treatment apparatus according to claim 4, wherein the water treatment units each further include a casing that surrounds the tilted plate and the discharge forming body, and

the casings of the water treatment units that are vertically adjacent are fastened to each other.

[Claim 6]

The water treatment apparatus according to any one of claims 1 to 5, wherein at least one of a tilt angle of the tilted plate, a flow rate of the water to be treated, and a discharge power is adjustable.

[Claim 7]

The water treatment apparatus according to claim 6, further comprising:

a water quality meter that detects a water quality of the water to be treated; and

a centralized control unit that adjusts at least one of the tilt angle of the tilted plate, the flow rate of the water to be treated, and the discharge power on the basis of information from the water quality meter.

[Claim 8]

The water treatment apparatus according to any one of claims 1 to 7, wherein the droplet forming apparatus is an ultrasonic transducer.

[Claim 9]

The water treatment apparatus according to any one of claims 1 to 7, wherein the droplet forming apparatus is an ultrasonic homogenizer.

[Claim 10]

The water treatment apparatus according to any one of claims 1 to 7, wherein the droplet forming apparatus is a splashing mechanism that forms droplets by mechanically splashing the water to be treated upward while contacting the water to be treated.

[Claim 11]

The water treatment apparatus according to any one of claims 1 to 7, wherein the droplet forming apparatus is a gas ejection apparatus that forms droplets by ejecting gas into the water to be treated so that the water to be treated splashes up.

[Claim 12]

The water treatment apparatus according to any one of claims 1 to 7, wherein a narrow hole is provided in the tilted plate so as to penetrate the tilted plate in a thickness direction, and the droplet forming apparatus is a gas ejection apparatus that forms droplets by ejecting gas upward through the narrow hole so that the water to be treated splashes up.

[Claim 13]

The water treatment apparatus according to any one of claims 1 to

7, further comprising a treatment tank that houses the tilted plate and the discharge forming body,

wherein a narrow hole is provided in the tilted plate so as to penetrate the tilted plate in a thickness direction, and

the droplet forming apparatus is a gas circulation apparatus that takes in gas from the treatment tank and ejects the intake gas upward through the narrow hole.

[Claim 14]

The water treatment apparatus according to claim 12 or 13, wherein, on the tilted plate, a thickness of the water film covering the narrow hole is greater than a thickness of the water film covering a region of the tilted plate other than the narrow hole.

[Claim 15]

The water treatment apparatus according to claim 14, wherein the tilted plate includes a lower plate in which the narrow hole is provided and an upper plate that overlaps the lower plate,

a through hole is provided in the upper plate,

an opening area of the through hole is larger than an opening area of the narrow hole, and

in a condition where the upper plate overlaps the lower plate, the narrow hole is disposed so as to open onto the through hole.

[Claim 16]

The water treatment apparatus according to any one of claims 1 to 15, wherein the droplets are caused to collide with the discharge forming body.

[Claim 17]

The water treatment apparatus according to any one of claims 1 to 16, wherein the droplet forming apparatus is operated intermittently.

[Claim 18]

The water treatment apparatus according to any one of claims 1 to 17, wherein the droplet forming apparatus is operated in synchronization with formation of the discharge.

[Claim 19]

A water treatment method for treating water to be treated, comprising:

passing the water to be treated over an upper surface of a tilted plate disposed at an incline relative to a horizontal plane so that a water film is formed on the tilted plate while forming a discharge between at least a pair of electrodes disposed above the water film across a gas layer; and

exerting power on the water film so that at least some of the water to be treated shoots upward from the tilted plate in the form of droplets and the droplets come into contact with the discharge.

[Claim 20]

A water treatment method for treating water to be treated by passing the water to be treated over an upper surface of a tilted plate disposed at an incline relative to a horizontal plane so that a water film is formed on the tilted plate while forming a discharge between the tilted plate and an electrode disposed above the water film across a gas layer, and bringing the water film into contact with the discharge,

wherein at least some of the water to be treated shoots upward from the tilted plate in the form of droplets by exerting power on the water film.

[CLAIMS]

[Claim 1]

A water treatment apparatus comprising:

a tilted plate (2; 55) disposed at an incline relative to a horizontal plane so that water to be treated (4) flows over an upper surface thereof;

a discharge forming body (56a, 56b, 56c, 57a, 57b, 57c, 57d; 60a, 60b, 60c, 60d; 62a, 62b, 62c; 64; 65) that is disposed across a gas layer (71) above a water film (70) formed by the water to be treated (4) flowing over the tilted plate (2; 55), includes at least a pair of electrodes (56a, 56b, 56c, 57a, 57b, 57c, 57d; 60a, 60b, 60c, 60d; 62a, 62b, 62c; 64; 65), and forms a discharge by applying a voltage between the electrodes, and

a droplet forming apparatus (12a, 12b, 12c; 24; 25; 28; 45; 49; 53) configured to perform an operation for exerting power on the water film (70) so that droplets shoot up from the water film (70),

wherein treatment is performed on the water to be treated by bringing the droplets, which are formed by the power exerted by the droplet forming apparatus, into contact with the discharge.

[Claim 2]

A water treatment apparatus comprising:

a tilted plate (2; 55) disposed at an incline relative to a horizontal plane so that water to be treated (4) flows over an

upper surface thereof;

a discharge forming body (6a, 6b, 6c) that is disposed across a gas layer (71) above a water film (70) formed by the water to be treated (4) flowing over the tilted plate (2; 55), and forms a discharge by applying a voltage between the discharge forming body (6a, 6b, 6c) and the tilted plate (2; 55), and

a droplet forming apparatus (12a, 12b, 12c; 24; 25; 28; 45; 49; 53) configured to perform an operation for exerting power on the water film (70) so that droplets shoot up from the water film (70),

wherein treatment is performed on the water to be treated by bringing the droplets, which are formed by the power exerted by the droplet forming apparatus, into contact with the discharge.

[Claim 3]

The water treatment apparatus according to claim 1 or 2, wherein a plurality of water treatment units (19a, 19b, 19c, 19d; 47a, 47b, 47c, 47d; 51a, 51b, 51c, 51d; 79a, 79b, 80a, 80b), each including the tilted plate (2) and the discharge forming body (6a, 6b, 6c), are disposed so as to be arranged in a vertical direction, and

the respective tilted plates (2) are tilted in alternating opposite directions relative to the horizontal plane so that the water to be treated (4) flows continuously downward from an uppermost water treatment unit (19a; 47a; 51a; 79a) to a lowermost water treatment unit (19d; 47d; 51d; 80b).

[Claim 4]

The water treatment apparatus according to claim 3, wherein the water treatment units (19a, 19b, 19c, 19d; 47a, 47b, 47c, 47d; 51a, 51b, 51c, 51d; 79a, 79b, 80a, 80b) each further include a casing (83) that surrounds the tilted plate (2) and the discharge forming body (6a, 6b, 6c), and

the casings (83) of the water treatment units (19a, 19b, 19c, 19d; 47a, 47b, 47c, 47d; 51a, 51b, 51c, 51d; 79a, 79b, 80a, 80b) that are vertically adjacent are fastened to each other.

[Claim 5]

The water treatment apparatus according to any one of claims 1 to 4, wherein at least one of a tilt angle of the tilted plate (2; 55), a flow rate of the water to be treated (4), and a discharge power is adjustable.

[Claim 6]

The water treatment apparatus according to claim 5, further comprising:

a water quality meter (37) that detects a water quality of the water to be treated (4); and

a centralized control unit (35) that adjusts at least one of the tilt angle of the tilted plate (2; 55), the flow rate of the water to be treated (4), and the discharge power on the basis of information from the water quality meter (37).

[Claim 7]

The water treatment apparatus according to any one of claims 1 to 6, wherein the droplet forming apparatus (12a, 12b, 12c) is

an ultrasonic transducer (12a, 12b, 12c).

[Claim 8]

The water treatment apparatus according to any one of claims 1 to 6, wherein the droplet forming apparatus (24) is an ultrasonic homogenizer (24).

[Claim 9]

The water treatment apparatus according to any one of claims 1 to 6, wherein the droplet forming apparatus (28) is a splashing mechanism (28) that forms droplets by mechanically splashing the water to be treated (4) upward while contacting the water to be treated (4).

[Claim 10]

The water treatment apparatus according to any one of claims 1 to 6, wherein the droplet forming apparatus (25) is a gas ejection apparatus (25) that forms droplets by ejecting gas into the water to be treated (4) so that the water to be treated (4) splashes up.

[Claim 11]

The water treatment apparatus according to any one of claims 1 to 6, wherein a narrow hole (2a; 2b; 55a; 73) is provided in the tilted plate (2; 55) so as to penetrate the tilted plate (2; 55) in a thickness direction, and

the droplet forming apparatus (25; 45) is a gas ejection apparatus (25; 45) that forms droplets by ejecting gas upward through the narrow hole (2a; 2b; 55a; 73) so that the water to be treated (4) splashes up to shoot upward and form droplets.

[Claim 12]

The water treatment apparatus according to any one of claims 1 to 6, further comprising a treatment tank (1) that houses the tilted plate (2; 55) and the discharge forming body (6a, 6b, 6c; 56a, 56b, 56c, 57a, 57b, 57c, 57d; 60a, 60b, 60c, 60d; 62a, 62b, 62c; 64; 65),

wherein a narrow hole (2b; 55a; 73) is provided in the tilted plate (2; 55) so as to penetrate the tilted plate (2; 55) in a thickness direction, and

the droplet forming apparatus (45; 49; 53) is a gas circulation apparatus (45; 49; 53) that takes in gas from the treatment tank (1) and ejects the intake gas upward through the narrow hole (2b; 55a; 73).

[Claim 13]

The water treatment apparatus according to claim 11 or 12, wherein, on the tilted plate (2; 55), a thickness of the water film (70) covering the narrow hole (2a; 2b; 55a; 73) is greater than a thickness of the water film (70) covering a region of the tilted plate (2; 55) other than the narrow hole (2b; 55a; 73).

[Claim 14]

The water treatment apparatus according to claim 13, wherein the tilted plate (2; 55) includes a lower plate (76) in which the narrow hole (2a; 2b; 55a; 73) is provided and an upper plate (77) that overlaps the lower plate (76),

a through hole (77a to 77e) is provided in the upper plate

(77),

an opening area of the through hole (77a to 77e) is larger than an opening area of the narrow hole (2a; 2b; 55a; 73), and in a condition where the upper plate (77) overlaps the lower plate (76), the narrow hole (2a; 2b; 55a; 73) is disposed so as to open onto the through hole (77a to 77e).

[Claim 15]

The water treatment apparatus according to any one of claims 1 to 14, wherein the droplets (13a, 13b, 13c) are caused to collide with the discharge forming body (56a, 56b, 56c, 57a, 57b, 57c, 57d; 60a, 60b, 60c, 60d; 62a, 62b, 62c; 64; 65).

[Claim 16]

The water treatment apparatus according to any one of claims 1 to 15, wherein the droplet forming apparatus (12a, 12b, 12c; 24; 25; 28; 45; 49; 53) is operated intermittently.

[Claim 17]

The water treatment apparatus according to any one of claims 1 to 16, wherein the droplet forming apparatus (12a, 12b, 12c; 24; 25; 28; 45; 49; 53) is operated in synchronization with formation of the discharge.

[Claim 18]

A water treatment method for treating water to be treated comprising:

preparing a droplet forming apparatus configured to perform an operation for passing water to be treated (4) over an upper surface of a tilted plate (2; 55) disposed at an incline

relative to a horizontal plane so that a water film (70) is formed on the tilted plate while forming a discharge between at least a pair of electrodes (56a, 56b, 56c, 57a, 57b, 57c, 57d; 60a, 60b, 60c, 60d; 62a, 62b, 62c; 64; 65) disposed above the water film (70) across a gas layer (71), and exerting power on the water film (70) so that droplets (13a, 13b, 13c) shoot up from the water film (70); and

bringing the droplets (13a, 13b, 13c) formed by the power exerted by the droplet forming apparatus into contact with the discharge.

[Claim 19]

A water treatment method for treating water to be treated comprising:

preparing a droplet forming apparatus configured to perform an operation for passing the water to be treated (4) over an upper surface of a tilted plate (2; 55) disposed at an incline relative to a horizontal plane so that a water film (70) is formed on the tilted plate while forming a discharge between the tilted plate and an electrode disposed above the water film across a gas layer (71), and droplets (13a, 13b, 13c) shoot up from the water film (70); and

bringing the droplets (13a, 13b, 13c) formed by the power exerted by the droplet forming apparatus into contact with the discharge.