

CAVITATION WAVE AGGREGATOR

Technical Field

The invention relates to the technical field of wave aggregators, in particular to a cavitation wave aggregator.

Background Art

The cavitation wave aggregator is a highly efficient cleaning apparatus designed by leveraging the cavitation effect and pressure wave focusing effect. Its core components include an inlet, a jet channel, a collision zone, and an outlet. Through precise mechanical structure and fluid dynamics design, the device induces cavitation in the water flow, generating pressure waves within the resonance cavity. These pressure waves are then reflected and focused by a specially designed structure, creating a region of high pressure, high temperature, and high energy concentration. The cavitation bubbles fully grow in this region, and the enlarged bubbles rapidly annihilate upon contact with microorganisms via water jets, generating tremendous impact and shear forces; this enables the easy removal of adherents such as barnacles from ship hulls. The cavitation wave aggregator achieves efficient dirt removal and is suitable for various applications, including cleaning guns, cleaning discs, cleaning robots, dental water flossers, aquarium cleaning, dishwashers, and ship hull barnacle removal. With optimized designs such as adjustable delivery pipe sizes, flow deflectors, and turbulence enhancers, the cavitation wave aggregator can flexibly adapt to a wide range of cleaning tasks. It enhances cleaning efficiency while reducing energy consumption, offering broad industrial and domestic application prospects.

The traditional cavitation jet devices are driven by high-pressure water flow. After entering through the inlet, the water is accelerated through a specially designed jet channel, forming a high-speed jet flow at the outlet. Through the optimized design of the horn-shaped or gradually narrowing outlet, cavitation occurs in the low-pressure area, forming a large number of tiny bubbles. These bubbles release high temperature, high pressure, and strong shockwaves when they collide, compress, and rupture, which are used to remove surface dirt or attachments. The equipment is widely used in scenarios such as cleaning guns, cleaning discs, and barnacle removal from ship hulls. The water pressure and spray angle need to be manually adjusted according to task requirements to optimize cleaning effectiveness.

Traditional cavitation jet delivery pipelines usually have fixed sizes, making it difficult to adjust the opening size flexibly according to actual needs, which in turn makes it hard to meet the requirements of different cleaning tasks. This leads to an inability to adapt to varying flow and pressure demands, resulting in reduced efficiency.

In the cavitation wave aggregator provided by this invention, due to the wave-aggregating effect, high temperatures, high pressures, and immense energy are generated at the focal point. This causes cavitation bubbles to rapidly grow and then be ejected via a jet. When these bubbles come into contact with microorganisms, they promptly annihilate, generating tremendous impact and shear forces. As a result, adherents such as barnacles on ship hulls can be easily removed. The cavitation wave aggregator of the same size is at least twice as effective in cleaning as the cavitation jet device, and the former's effective working distance is more than five times that of the latter.

Summary of the Invention

To compensate for the aforementioned shortcomings, the invention provides a cavitation wave aggregator, which aims to address the issue that traditional cavitation wave aggregators struggle to meet the requirements of different cleaning tasks, consequently failing to adapt to varying flow rates and pressure demands, leading to a decrease in efficiency.

In order to achieve the above purpose, the invention provides the following technical solution: a cavitation wave aggregator, comprising a connecting pipe, wherein one end of the connecting pipe is fixedly connected to an adjusting pipe, one end of the adjusting pipe is fixedly connected to a cavitation generator, both interiors of the connecting pipe and the adjusting pipe are provided with a resonance cavity, an interior of the cavitation generator is provided with a cavitation generation tube, water flows from direction A to direction B inside the resonance cavity, and is conveyed inside the cavitation generation tube within the cavitation generator, the water flow is accelerated and the local pressure is reduced through the cavitation generation tube, thereby inducing the formation of bubbles and creating microbubbles, pressure waves generated by the resonance cavity propagate through fluid in the form of sound waves and are finally reflected and focused by an arc-shaped wave-aggregating port, creating a high-pressure, high-temperature, and high-energy concentration zone, bubbles fully grow in this zone, and the grown bubbles rapidly collapse

upon contact with microorganisms via water jets, generating tremendous impact and shear forces, which can easily remove attachments such as barnacles from a hull bottom, the arc-shaped wave-aggregating port is cup-shaped with an arc-shaped cross-section, specifically designed to focus pressure waves, a rotating plate is rotatably connected inside the adjusting pipe, an outer wall of the rotating plate is equipped with a driving component, the driving component is used to drive the rotation of the rotating plate, an inner wall of the rotating plate is provided with an adjusting component, the adjusting component is used to adjust a size of the resonance cavity;

the adjusting component comprises push plates, one end of each push plate is fixedly connected to the inner wall of the rotating plate, a sliding rod is slidably connected inside each corresponding push plate, an outer wall of each sliding rod is fixedly connected to a triangular plate, an outer wall of each triangular plate is fixedly connected to a sealing gasket, the interior of the adjusting pipe is fixedly connected with guide plates, and sliding slots are arranged inside the guide plates.

Further, the driving component comprises a worm gear, an outer wall of the worm gear is fixedly connected to the outer wall of the rotating plate, the interior of the adjusting pipe is rotatably connected with a driving rod, an outer wall of the driving rod is fixedly connected to a worm, the worm meshes with the worm gear.

Further, one side of an outer wall of each guide plate is fixedly connected to the outer wall of the rotating plate, the guide plates are used for sealing the rotating plate, outer walls of the triangular plates are slidably connected to an inner ring of the rotating plate, and the inner ring of the rotating plate is used for further sealing.

Further, one end of the connecting pipe is fixedly connected to a connecting flange, and the connecting flange is used to facilitate the disassembly and assembly of the cavitation wave aggregator.

Further, both ends of each sliding rod are slidably connected inside each sliding slot, and the sliding slots are used to guide movements of the sliding rods.

Further, an outer wall of the worm is rotatably connected inside the adjusting pipe, and the worm is used to drive the worm gear to rotate.

Further, the interior of the cavitation generator is designed in an hourglass shape; when

water flows through a narrow section of the hourglass shape, due to the reduction in cross-sectional area, the water flow velocity significantly increases, forming a high-speed jet.

Further, the arc-shaped wave-aggregating port is arranged at one end of the cavitation generation tube, the arc-shaped wave-aggregating port is cup-shaped with an arc-shaped cross-section, specifically designed to focus pressure waves and enhance the impact force of bubbles.

The invention has the following advantageous effects:

1. in the invention, the pressure waves are initially generated in the resonance cavity through the connecting pipe, the adjusting pipe, and the resonance cavity itself; subsequently, the cavitation generator accelerates the water flow and reduces local pressure, thereby inducing the formation of bubbles and creating microbubbles. The pressure waves generated by the resonance cavity propagate through the fluid in the form of sound waves; finally, these waves are focused by reflection through the arc-shaped wave-aggregating port, creating a region of high pressure, high temperature, and high energy concentration. In this, the bubbles fully grow, and the enlarged bubbles rapidly annihilate upon contact with microorganisms via water jets, generating tremendous impact and shear forces, and this enables the easy removal of adherents such as barnacles from the ship's hull.

2. In this invention, the driving rod is first rotated to cooperate with the worm and worm gear, driving the rotating plate to turn; subsequently, the positions of the triangular plates are adjusted in coordination with the push plates, sliding rods, sealing gaskets, guide plates, and sliding slots, achieving resonance cavity regulation. This addresses the issue where the cavitation wave aggregator struggles to meet the demands of different cleaning tasks, making it difficult to adapt to varying flow rates and pressure requirements, resulting in decreased efficiency. It achieves adjustable opening sizes to accommodate different cleaning needs, while also enhancing the cavitation phenomenon through efficient impact, leading to superior cleaning results.

Brief Description of Accompanying Drawings

FIG. 1 is a three-dimensional structural diagram of a cavitation wave aggregator proposed in this invention;

FIG. 2 is a schematic diagram of an internal structure of the adjusting pipe of the

cavitation wave aggregator proposed in this invention;

FIG. 3 is a schematic diagram of one side of the guide plate structure of the cavitation wave aggregator proposed in this invention;

FIG. 4 is a schematic diagram of the resonance cavity of the cavitation wave aggregator proposed in this invention;

FIG. 5 is a schematic diagram of the energy focusing capability of the cavitation wave aggregator proposed in this invention;

FIG. 6 is a schematic diagram of a cross-section of the arc-shaped wave-aggregating port proposed in this invention.

In the figures: 1 connecting pipe; 2 cavitation generator; 3 adjusting pipe; 4 driving rod; 5 worm; 6 rotating plate; 7 worm gear; 8 push plate; 9 sliding rod; 10 triangular plate; 11 sealing gasket; 12 guide plate; 13 sliding slot; 14 connecting flange; 15 resonance cavity; 16 cavitation generation tube; 17 arc-shaped wave-aggregating port.

Specific Embodiment of the invention

The technical schemes in the embodiments of the invention will be clearly and completely described in combination with the accompanying drawings in the embodiments of the invention. Obviously, the described embodiments are only some of the embodiments of the invention, but not all of the embodiments. Based on the embodiments in this invention, all other embodiments obtained by those of ordinary skill in the art without making creative efforts shall fall within the protection scope of this invention.

Embodiments:

Referring to FIG. 1 to FIG. 6, the invention provides one embodiment: a cavitation wave aggregator, comprising a connecting pipe 1, wherein one end of the connecting pipe 1 is fixedly connected to an adjusting pipe 3, one end of the adjusting pipe 3 is fixedly connected to a cavitation generator 2, the cavitation generator 2 is used to accelerate water flow and reduce local pressure, both interiors of the connecting pipe 1, the cavitation generator 2 and the adjusting pipe 3 are provided with a resonance cavity 15, the resonance cavity 15 is used to convey water flow to create a cavitation effect, an interior of the cavitation generator 2 is provided with a cavitation generation tube 16, water flows from direction A to direction B inside the resonance cavity 15, and is conveyed inside the cavitation generation tube 16

within the cavitation generator 2, the water flow is accelerated and the local pressure is reduced through the cavitation generation tube 16, thereby inducing the formation of bubbles and creating microbubbles, pressure waves generated by the resonance cavity 15 propagate through fluid in the form of sound waves and are finally reflected and focused by an arc-shaped wave-aggregating port 17, creating a high-pressure, high-temperature, and high-energy concentration zone, bubbles fully grow in this zone, and the grown bubbles rapidly collapse upon contact with microorganisms via water jets, generating tremendous impact and shear forces, which can easily remove attachments such as barnacles from a hull bottom, a rotating plate 6 is rotatably connected inside the adjusting pipe 3, an outer wall of the rotating plate 6 is equipped with a driving component, the driving component is used to drive the rotation of the rotating plate 6, an inner wall of the rotating plate 6 is provided with an adjusting component, the adjusting component is used to adjust a size of the resonance cavity 15;

the adjusting component comprises push plates 8, one end of each push plate 8 is fixedly connected to the inner wall of the rotating plate 6, a sliding rod 9 is slidably connected inside each corresponding push plate 8, an outer wall of each sliding rod 9 is fixedly connected to a triangular plate 10, the triangular plates 10 are used to adjust an opening angle of the resonance cavity 15, an outer wall of each triangular plate 10 is fixedly connected to a sealing gasket 11, the sealing gaskets 11 provide a sealing function to prevent water leakage, the interior of the adjusting pipe 3 is fixedly connected with guide plates 12, the guide plates 12 remain stable through a fixed structure, sliding slots 13 are arranged inside the guide plates 12, the sliding slots 13 are used to guide the movements of the sliding rods 9, ensuring the precision of the adjusting component; the driving component comprises a worm gear 7, an outer wall of the worm gear 7 is fixedly connected to the outer wall of the rotating plate 6, the interior of the adjusting pipe 3 is rotatably connected with a driving rod 4, an outer wall of the driving rod 4 is fixedly connected to a worm 5, the worm 5 meshes with the worm gear 7, the driving rod 4 is driven to rotate the worm 5, thereby bringing the meshing engagement between the worm 5 and the worm gear 7, causing the rotating plate 6 to rotate in accordance with the rotation of the worm 5.

Referring to FIG. 1 to FIG. 6, one side of an outer wall of each guide plate 12 is fixedly

connected to the outer wall of the rotating plate 6, the guide plates 12 are used for sealing the rotating plate 6, outer walls of the triangular plates 10 are slidably connected to an inner ring of the rotating plate 6, and the inner ring of the rotating plate 6 is used for further sealing; one end of the connecting pipe 1 is fixedly connected to a connecting flange 14, and the connecting flange 14 is used to facilitate the disassembly and assembly of the cavitation wave aggregator; both ends of each sliding rod 9 are slidably connected inside each sliding slot 13, and the sliding slots 13 are used to guide movements of the sliding rods 9; an outer wall of the worm 5 is rotatably connected inside the adjusting pipe 3, and the worm 5 is used to drive the worm gear 7 to rotate; due to the sudden reduction in cross-sectional area of the cavitation generation tube 16, the water flow velocity increases significantly, forming a high-speed jet; the cavitation generation tube 16 is arranged at one end of the resonance cavity 15 and is used to generate cavitation bubbles; the arc-shaped wave-aggregating port 17 focuses the pressure waves generated by the resonance cavity 15 through reflection, creating a region of high pressure, high temperature, and high energy concentration, and this promotes the growth of bubbles and significantly enhances the impact force of the cavitation bubbles.

Working Principle: when the cavitation wave aggregator is required for use, a jet impactor is employed to convey water flow into the resonance cavity 15, generating pressure waves; subsequently, the water flow is accelerated and the local pressure is reduced through the cavitation generation tube 16, thereby inducing the formation of bubbles and creating microbubbles; additionally, the pressure waves primarily generated by the resonance cavity 15 propagate through the fluid in the form of sound waves; finally, these waves are focused by reflection through the arc-shaped wave-aggregating port 17, creating a region of high pressure, high temperature, and high energy concentration, promoting the growth of bubbles; the enlarged bubbles are then carried by the jet flow and come into contact with microorganisms, then they annihilate, generating tremendous impact and shear forces to clean barnacles from the hull bottom. Before using the cavitation wave aggregator, the driving rod 4 is driven to rotate the worm 5, which in turn drives the rotating plate 6 to rotate between the two guide plates 12 via the worm gear 7, then the rotation of the rotating plate 6 then moves the push plates 8, causing the sliding rods 9 to slide within internal tracks of the push plates 8 while simultaneously sliding the bottoms of the sliding rods 9 within the pre-set sliding slots

13 inside the guide plates 12; this movement drives the triangular plates 10 to move. Due to the pulling action of multiple push plates 8, multiple triangular plates 10 slide internally within the guide plates 12, gradually separating multiple triangular plates 10 to form an equilateral hexagonal opening, allowing water flow to pass through; this achieves control over the opening size of the resonance cavity 15, thereby meeting varying impact requirements.

Finally, it should be noted that the above description is only preferred embodiments of the invention and is not intended to limit the invention. Although the invention has been described in detail with reference to the above embodiments, those skilled in the art can still modify the technical solutions described in the above embodiments or replace some of the technical features with equivalents. Any modification, equivalent replacement, improvement, etc. made within the spirit and principles of the invention shall be included in the scope of protection of the invention.

CLAIMS

1. A cavitation wave aggregator, comprising a connecting pipe, wherein one end of the connecting pipe is fixedly connected to an adjusting pipe, one end of the adjusting pipe is fixedly connected to a cavitation generator, both interiors of the connecting pipe and the adjusting pipe are provided with a resonance cavity, an interior of the cavitation generator is provided with a cavitation generation tube, water flows from direction A to direction B inside the resonance cavity, and is conveyed inside the cavitation generation tube within the cavitation generator, the water flow is accelerated and the local pressure is reduced through the cavitation generation tube, thereby inducing the formation of bubbles and creating microbubbles, pressure waves generated by the resonance cavity propagate through fluid in the form of sound waves and are finally reflected and focused by an arc-shaped wave-aggregating port, creating a high-pressure, high-temperature, and high-energy concentration zone, bubbles fully grow in this zone, and the grown bubbles rapidly collapse upon contact with microorganisms via water jets, generating tremendous impact and shear forces, which can easily remove attachments such as barnacles from a hull bottom, the arc-shaped wave-aggregating port is cup-shaped with an arc-shaped cross-section, specifically designed to focus pressure waves, a rotating plate is rotatably connected inside the adjusting pipe, an outer wall of the rotating plate is equipped with a driving component, the driving component is used to drive the rotation of the rotating plate, an inner wall of the rotating plate is provided with an adjusting component, the adjusting component is used to adjust a size of the resonance cavity;

the adjusting component comprises push plates, one end of each push plate is fixedly connected to the inner wall of the rotating plate, a sliding rod is slidably connected inside each corresponding push plate, an outer wall of each sliding rod is fixedly connected to a triangular plate, an outer wall of each triangular plate is fixedly connected to a sealing gasket, the interior of the adjusting pipe is fixedly connected with guide plates, and sliding slots are arranged inside the guide plates.

2. The cavitation wave aggregator of claim 1, wherein the driving component comprises a worm gear, an outer wall of the worm gear is fixedly connected to the outer wall of the rotating plate, the interior of the adjusting pipe is rotatably connected with a driving rod, an outer wall of the driving rod is fixedly connected to a worm, the worm meshes with the worm gear.
3. The cavitation wave aggregator of claim 1, wherein one side of an outer wall of each guide plate is fixedly connected to the outer wall of the rotating plate, the guide plates are used for sealing the rotating plate, outer walls of the triangular plates are slidably connected to an inner ring of the rotating plate, and the inner ring of the rotating plate is used for further sealing.
4. The cavitation wave aggregator of claim 2, wherein one end of the connecting pipe is fixedly connected to a connecting flange, and the connecting flange is used to facilitate the disassembly and assembly of the cavitation wave aggregator.
5. The cavitation wave aggregator of claim 1, wherein both ends of each sliding rod are slidably connected inside each sliding slot, and the sliding slots are used to guide movements of the sliding rods.
6. The cavitation wave aggregator of claim 2, wherein an outer wall of the worm is rotatably connected inside the adjusting pipe, and the worm is used to drive the worm gear to rotate.
7. The cavitation wave aggregator of claim 1, wherein the interior of the cavitation generator is designed in an hourglass shape; when water flows through a narrow section of the hourglass shape, due to the reduction in cross-sectional area, the water flow velocity significantly increases, forming a high-speed jet.
8. The cavitation wave aggregator of claim 1, wherein the arc-shaped wave-aggregating port is arranged at one end of the cavitation generation tube, the arc-shaped wave-aggregating port

is cup-shaped with an arc-shaped cross-section, specifically designed to focus pressure waves and enhance the impact force of bubbles.