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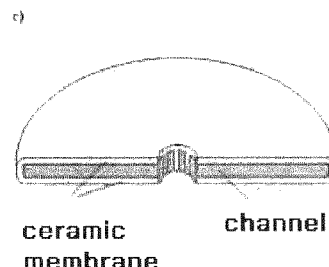
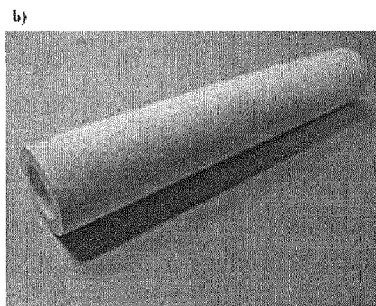
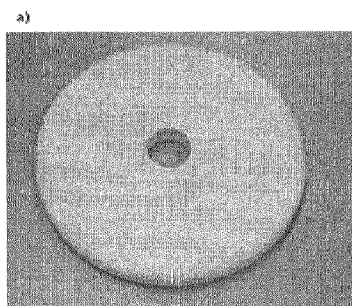
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(54) Title: SILICA OR ALUMINA CERAMIC DIFFUSER FOR GENERATING MICROBUBBLES, METHOD FOR MANUFACTURING THE SAME AND METHOD FOR WASTEWATER TREATMENT USING AIR- FLOTATION PROCESS USING THE SAME



(57) Abstract: Silica or alumina based ceramic diffusers generate microbubbles for solid-liquid separation of pollutants in wastewater. Methods for manufacturing the diffusers and methods for wastewater treatment based on air-flotation using the diffusers are also disclosed. The ceramic diffuser is capable of achieving a particle size distribution in which the sizes of silica or alumina particles increase in the direction towards the center with particles on the surface being the smallest. Thus a small air pressure around 1 atm is capable of providing a uniform and steady stream of microbubbles for securing a rapid flotation of pollutants in wastewater. In addition, the ceramic diffuser can be used conveniently and semi-permanently without maintenance problems, adding to its economic advantage. Furthermore, the enhanced productivity arising from the use of the extrusion molding process for producing the ceramic diffusers supports additional cost reduction.

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【DESCRIPTION】**【Invention Title】**

SILICA OR ALUMINA CERAMIC DIFFUSER FOR GENERATING MICROBUBBLES, METHOD FOR MANUFACTURING THE SAME AND METHOD FOR WASTEWATER TREATMENT USING AIR-FLOATATION PROCESS USING THE SAME

【Technical Field】

The present invention relates to silica or alumina based ceramic diffusers that generate microbubbles for solid-liquid separation of pollutants in wastewater as well as methods for manufacturing said diffusers. The present invention also relates to methods for wastewater treatment based on air-flotation using said diffusers.

【Background Art】

Membrane filters filter and separate pollutants, organic matter and microbial particles such as bacteria in wastewater through their micropores. Widely used in the field of water treatment, membrane filters are mostly involved in municipal and drinking water treatment. They, however, frequently suffer from fouling caused by highly concentrated pollutants.

Water treatment based on air-flotation is most frequently used in the treatment of organic wastewater or sludge from aeration tank where biological oxygen demands(BODs) and suspended solid (SS) levels are typically high. Among air-flotation methods, dissolved air- flotation (DAF) is the one most widely used. Dissolved air-flotation is described in such prior arts as Korean Patent Publications No. 10-0155482 and No. 10-0351111. Still, this method has its own problems. It requires high capacity air compressors since supplying dissolved air necessitates high pressures of 4-5 atmospheres. It also require wide areas for installation and suffers from high running costs.

Recently, air-flotation based on microbubbles has come into more frequent use in order to overcome the shortcomings mentioned above. In this method, water to be treated is provided with artificially produced

microbubbles in place of air bubbles from pressurized, supersaturated dissolved air. These microbubbles cause solid pollutants to rise to the top, eventually leading to the removal of the separated solid by, for example, a skimmer.

Generating very fine bubbles at a uniform pace is vital for floating solids in air-flotation based on microbubbles. One may include Korean Patent Publication No. 10-0315903 and Korean Utility Model Publication No. 20-0359766 as prior art examples on microbubble formation. These inventions, however, suffers from maintenance problems arising from the complicated design of diffusers, poor economic efficiency due to the use of high pressure pumps or pressurizing tanks and limited applicability associated with the inability to control air bubble sizes.

Also, attempts have been made to utilize electro-flotation (EF) methods, where electrode plates are used to generate microbubbles. EF methods, however, involve high installation costs due to their use of special electric systems such as rectifiers. They are also plagued with scale formation on the electrode plates when allowed to run for a long time.

【Disclosure】

【Technical Problem】

To address the problems mentioned above, the present invention aims to provide silica or alumina-based ceramic diffusers consisting of dense and uniform ceramic particles, the ideal particle distribution of which supports a steady generation of fine air bubbles. The present invention also aims to provide methods for producing said diffusers.

【Technical Solution】

In order to achieve the objectives mentioned above, the present invention provides a ceramic diffuser based on silica or alumina capable of generating microbubbles, for separating pollutants through flotation, wherein said diffuser is a calcined silica or alumina powder compact.

The inventive diffuser is characterized in that it has such particle size distribution that as one proceeds from the surface to the inside, particle sizes increase. In one embodiment, the pore sizes of the inventive diffuser are in the range of 0.001 μm -0.05 μm . In addition, said diffuser is characterized in that it is either disc-shaped or pipe-shaped. Said pipe-shaped diffuser characteristically has a length ranging from 16 to 100 cm.

The inventive diffuser is characterized in that the size of microbubbles formed by said diffuser ranges from 1 to 100 μm , preferably 40 to 60 μm .

The present invention also provides a method for producing pipe-shaped ceramic diffusers based on silica or alumina capable of generating microbubbles comprising: (a) preparing a wet powder of silica or alumina; (b) feeding a extruder with the wet powder; (c) placing a vibrator at the nozzle of said extruder; (d) applying vibration under pressure to the wet powder in the extruder using the vibrator to form an extrusion molded product and (e) removing the extrusion molded product out of said nozzle and calcining said extrusion molded product in an oxidative atmosphere furnace.

The present invention is characterized in that the pressure applied is in the range of 300 to 600 tons.

The present invention also provides a method for producing disc-shaped ceramic diffusers based on silica or alumina capable of generating microbubbles comprising: (a) preparing a wet powder of silica or alumina; (b) feeding concave metallic mold 1 with the wet powder; (c) inserting a polyvinyl chloride film to the fed wet powder after the feeding; (d) feeding said concave metallic mold 1 with the wet powder on top of the inserted film; (e) leveling the top surface of the fed wet powder after the second feeding (f) pre-molding the fed wet powder by driving convex metallic mold 2 into

said wet powder with pressure; (g) applying vibration under pressure to the pre-molded wet powder using the supersonic vibrator 11 placed at least one of the molds 1 and 2 to form a molded product and (h) removing the molded product from said molds 1 and 2 and calcining said molded product in an oxidative atmosphere furnace.

In an embodiment of the present invention, the film has a thickness in the range of 0.25-0.5 mm. In another embodiment, said supersonic vibrator(s) 11 is/are placed either (a) inside said convex metallic mold 2 or (b) inside the support 22 to which said concave metallic mold 1 is fixed or (c) one each at both said places of (a) and (b). In still another embodiment, vibration separator(s) 12 is/are placed either (a) at the vicinity of said supersonic vibrator 11 and said support 22 wherein said supersonic vibrator 11 is fixed thereto or (b) at the vicinity of press 23 and supersonic vibrator 11 inside said convex metallic mold 2 or (c) one each at both said places of (a) and (b) so as to block the propagation of the vibration toward said support 22 and press 23. In one embodiment of the present invention, the removal of the molded product comprises a movement by piston 21 connected to an actuator capable of vertically moving up and down. Also the driving pressure of said concave metallic mold 2 is in the range of 100 to 200 tons and said pressure applied with vibration is in the range of 10 to 30 tons.

In a specific embodiment of the present invention, the temperature of said oxidative atmosphere furnace is in the range of 900°C-1,300°C. In addition, said wet powder is a mixture of binder solution with either a silica or alumina powder which said ceramic diffuser is based thereon. In another embodiment, said vibration is applied at a frequency range of 20,000 to 25,000 hertz.

In one aspect of the present invention, a method for treating wastewater by air-flotation is provided wherein microbubbles generating from said

ceramic diffuser float pollutants to form concentrated sludge layer on the upper part and a layer of treated water on the lower part of the treatment cell. In one embodiment, an aeration through said ceramic diffuser is achieved under a pressure of 0.8-1.2 atmospheres.

【Advantageous Effects】

The ceramic diffuser of the present invention has a particle size distribution in which the particle sizes of silica or alumina powder increase in the direction toward its center since during the manufacturing of said diffuser, pressure is applied along with shaking. Thus a small air pressure around 1 atm is capable of providing a uniform and steady stream of microbubbles for securing a rapid flotation of pollutants in wastewater. In addition, the air-flotation method of the present invention does not suffer from scale formation as is the case with electro-flotation with electrode plates. This allows the inventive ceramic diffuser to be used conveniently and semi-permanently without maintenance problems, adding to its economic advantage. Furthermore, the enhanced productivity arising from the use of the inventive extrusion molding process for producing said ceramic diffusers supports additional cost reduction.

【Description of Drawings】

Figure 1a is a photograph showing a finished product of the disc-shaped ceramic diffuser of the present invention. Figure 1b is a photograph showing a finished product of the pipe-shaped ceramic diffusers of the present invention. Figure 1c is a cross section of the inventive disc-shaped ceramic diffuser.

Figure 2a is a schematic diagram showing bubbles generated from the disc-shaped ceramic diffuser of the present invention. Figure 2b is a photograph showing bubbles generated from the disc-shaped ceramic diffuser of the present invention. Figure 2c a schematic diagram showing bubbles generated from the pipe-shaped ceramic diffuser of the present invention. Figure 2d is a photograph showing bubbles generated from the pipe-shaped ceramic diffuser of the present invention.

Figure 3 is a vertical cross section illustrating the operation of the

apparatus for manufacturing the inventive disc-shaped ceramic diffuser.

Figure 4a is a photograph showing the microbubble-induced flotation results in example 1 of the present invention immediately after the introduction of sludge. Figure 4b is a photograph showing the microbubble-induced flotation results in example 1 of the present invention 5 minutes after the introduction of sludge. Figure 4c is a photograph showing the microbubble-induced flotation results in example 1 of the present invention 10 minutes after the introduction of sludge. Figure 4d is a photograph showing the top surface after solid/liquid separation of sludge by air-flotation using microbubbles.

Figure 5 is a top view showing the configuration of electrode plates in comparative example 1 of the present invention.

Figure 6 is a photograph comparing electrode plates with scale deposit (left) in comparative example 1 with the same electrode plates before scale deposition (right).

<Description to the reference numbers in the drawings>

- 1 : concave metallic mold
- 2 : convex metallic mold
- 11 : supersonic vibrator
- 12 : vibration separator
- 21 : piston
- 22 : support
- 23 : press
- 31 : electrode plate

【Best Mode】

The present invention will be described in more detail below.

The inventive ceramic diffuser based on silica or alumina generates microbubbles so as to float pollutants to the top and separate them. The pore size of said silica or alumina-based ceramic diffuser can be chosen from a range of 0.001 μm to 0.05 μm depending on the size of the bubble to be generated. The size of the microbubbles generated from said diffuser is in the range of 1 to 100 μm , and preferably in the range of 40 to 60 μm . This is because larger bubbles are incapable of effectively floating pollutants, leading to a sharp drop in purification capacity.

The inventive ceramic diffuser based on silica or alumina is preferably a disc or pipe. In particular, it is preferred that said pipe-shaped diffusers have lengths in the range of 16-100 centimeters, since the pressure of air moving inside the ceramic diffuser becomes less uniform when the length of the inventive diffusers is out of the stipulated range.

Figure 1a is a photograph showing a finished product of the disc-shaped ceramic diffuser of the present invention. Figure 1b is a photograph showing a finished product of the pipe-shaped ceramic diffuser of the present invention. The diameter of the inventive disc-shaped ceramic diffuser was 15.8 cm. The air inlet (the central circle in Figure 1a) for pressurizing the internal channel of said diffuser had a diameter of 1 inch and a thickness of 0.8 cm. The pipe-shaped ceramic diffuser had an outer diameter of 4.0 cm, and a length of 18 cm. Figure 1c shows a cross section of a disc-shaped ceramic diffuser according to an embodiment of the present invention.

Figure 2a is a schematic diagram showing the actual generation of bubbles by a disc-shaped ceramic diffuser according to an embodiment of the present invention when applied to a reactor. Figure 2b is the corresponding photograph. The structure in the center connected to 4 disc-shaped diffusers serves as a passage for air. The air introduced through this passage

pressurizes the internal channel shown in Figure 1c, generating bubbles on the entire surface of the ceramic diffuser. Figure 2c is a schematic diagram of a pipe-shaped ceramic diffuser according to an embodiment of the present invention in which bubbles generated from said diffuser are shown. Figure 2d is the corresponding photograph.

A vibrator is placed either at the metallic molds or the nozzle so as to propagate vibration from the surface to the center of the ceramic diffuser. This enables the ceramic diffuser to achieve an ideal particle size distribution in which not only the silica or alumina particles are dense but the particle size increases in the direction toward the center with particles on the surface being the smallest. Furthermore, the semi-dry molding step and high temperature calcination step in the production of the inventive ceramic diffuser produces particles with uniform size and dense, regular configuration.

Figure 3 is a vertical cross section of illustrating the operation the apparatus for manufacturing the disc-shaped ceramic diffuser according to an embodiment of the present invention.

In the manufacture of said ceramic diffuser, highly purified silica or alumina devoid of impurities is ground into a fine powder first. This powder is mixed with an aqueous solution containing organic binders such as polyvinyl alcohol (PVA) to form a wet powder suitable for molding. Ceramic diffusers made from alumina powders require application of relatively higher air pressure for operation than those made from silica, albeit being capable of generating finer bubbles and having a superior strength. In contrast, ceramic diffusers made from silica powders is able to operate under low air pressure, and thus are economical. Also silica-based diffusers have adequate strength for air-flotation of wastewater sludge, even if they may not be as strong as alumina-based ones. Therefore, both types of ceramic diffusers are

suitable and complement each other for generating microbubbles in the solid/liquid separation by air-flotation.

1) Disc-shaped ceramic diffusers

The next step following the production of the wet powder is the initial filling of the concave metallic mold 1 with this wet powder. A film made from an organic material such as polyvinyl chloride (PVC) with a thickness of 0.25-0.5 mm is inserted to this wet powder. The thickness of this film is one of the factors decisive in determining the overall thickness of the ceramic diffuser. As the thickness of the ceramic diffuser increases, more ceramic powder is required and this lowers the economic efficiency. Thus, a film with a thickness of 0.25-0.5 mm is preferable for the optimization of the amount of ceramic powder used and the size distribution of bubbles to be generated. On top of this film, a second filling of said wet powder is performed and the top surface is leveled evenly. The convex metallic mold 2 is then driven into said wet powder by a press under a pressure of 100-200 tons for the initial compression, yielding a pre-molded ceramic diffuser out of the uncalcined wet powder. When the driving pressure of the press falls below 100 tons, larger bubbles are generated due to the insufficient compression of silica or alumina powder. When this pressure exceeds 200 tons, breakage of the ceramic diffuser occurs during high temperature molding. Therefore, the driving pressure of the press is preferably in the range of 100-200 tons.

In the following step, the pre-molded ceramic diffuser is subject to a supersonic vibration generated by the supersonic vibrator 11 placed on the press metallic mold. Concurrent with this vibration is the compression by the press with a pressure of 10-30 tons, forming the final ceramic diffuser. The pressure range of 10-30 tons allows the vibrator 11 to hold the ceramic diffuser. In addition, this pressure range allows particles to be distributed evenly instead of most being spread out towards the edges.

Therefore, said pressure range is preferred.

Through concave metallic mold 1 and convex metallic mold 2, the supersonic vibration propagates from the surface of said ceramic diffuser to its center. Small particles in the constituent ceramic powder move toward the vibrating source due to their small diameter and weight. This movement creates a particle size distribution in which particle size increases in the direction towards the center with particles on the surface being the smallest, hence to yield an ideal ceramic diffuser. In the final step of the manufacture, convex metallic mold 2 is removed first, followed by a lifting movement of piston 21, taking the ceramic diffuser formed out of concave metallic mold 1.

2) Pipe-shaped ceramic diffusers

Extrusion molding is used for the manufacture since this method is quite economical in that it can produce up to 4 meters of product per minute.

The extruder is filled with the wet powder prepared. To the nozzle of this extruder is installed a supersonic vibrator which produces vibration as the wet powder is extruded with a pressure in the range of 300-600 tons. Outside this pressure range, powder cannot be uniformly distributed so that it becomes difficult to generate evenly-sized bubbles. Therefore this pressure range is preferred for the extrusion molding step.

After the disc- or pipe-shaped ceramic diffusers are formed, they are introduced in an oxidative atmosphere furnace and calcined at 900°C-1,300°C to yield the ceramic diffuser of the present invention. The maximum limiting temperature under which these ceramic powders can be melted is approximately 1,200°C for silica powders and 1,400°C for alumina powders. Calcination under such high temperatures supports very fine pores, which in turn leads fine air bubbles. Meanwhile, considering that these ceramic diffusers will be placed at

the lower parts of wastewater precipitation tanks, these inventive ceramic diffusers should be capable of withstanding water pressure in the precipitation tank, generating air bubbles, and withstanding the pressure of the air introduced. Within the temperature range given above, an optimal compression of the ceramic powder can be achieved to provide the ceramic diffuser with required strength. Therefore, calcination is preferably performed at the given temperature range. The actual method of calcination need not be limited to specific methods.

The use of supersonic vibration enables the ceramic diffusers to achieve ideal particle size distribution even when cheaper, relatively coarse materials are used instead materials of fine particle sizes in the manufacture of the inventive ceramic diffusers. The frequency and duration of such supersonic vibration can be properly adjusted according to the shape and size of the particles. In the case of fine alumina or silica powders, 20,000–25,000 vibrations per second are preferred.

【Mode for Invention】

The present invention will be explained in detail with specific embodiments and examples given below. The following embodiments and examples are for the purpose of illustration only, and by no means meant for limiting the scope of the present invention.

<Example 1: Separation by air-flotation using ceramic diffuser for generating microbubbles >

The ability of the inventive ceramic diffusers to float pollutants by microbubbles was tested using a 70-liter reactor. Mixed liquor suspended solids (MLSS, approximately 3,000 mg/L) used for regular activated sludge wastewater treatments were chosen as the pollutant. Air was introduced to said ceramic diffuser at 0.8 bar pressure to generate microbubbles. 4 disc-shaped ceramic diffusers were placed vertically at the bottom part of the

reactor. The air-flotation was performed at about 1 meter below the water level.

The results of a 10-minute air-flotation using microbubbles generated from the inventive ceramic diffuser, in which the rise of the sludge were observed are shown in Figures 4a to 4d. As shown clearly in these Figures, approximately 10 minutes of aeration after the introduction of sludge resulted in an effective solid/liquid separation.

<Comparative Example 1 : Separation by electro-flotation using electrode plates>

The ability to float pollutants by microbubbles generated from electrolysis using aluminum or steel electrode plates was tested using a 70-liter reactor. Mixed liquor suspended solids (approximately 3,000 mg/L) used for regular activated sludge wastewater treatments were chosen as the pollutant. Two rows of electrode plate 3l unit consisting of one anode and two cathodes were placed at the bottom part of the reactor as shown in Figure 5. The air-flotation was performed at about 1 meter below the water level.

<Experimental Example 1 : Measuring the size of microbubbles generated>

The sizes of the microbubbles generated in example 1 and comparative example 1 were measured. The relation between the size of the generated bubbles and the size of the particles to be subject to solid/liquid separation may determine the collision efficiency, and in turn affect flotation capacity. The sizes of the bubbles generated were measured with a particle counter (LaserTrac Model PC 2400D, Hemtrac, USA)

The microbubbles from the ceramic diffuser in example 1 had an average diameter of 51.67 ± 0.51 μm under the pressure of 0.8 bar. The microbubbles from electrode plates in comparative example 1 had an average diameter of 34.43 ± 0.51 μm at the voltage of 220 V, current of 450 mA and current

density of 89.52 A/m^2 . Microbubbles with sizes suitable for an effective air-flotation were formed in both examples. In comparative example 1, however, scale accumulates on the electrode plates, as shown in Figure 6, when the reactor is run over a long time. This scale formation diminishes the efficiency of the electrode plates, which in turn leads to fewer microbubbles formed and lessened air-flotation capacity.

<Experimental Example 2 : Measuring the concentrations of sludge concentrated on top and in the effluent>

The concentrations of the sludge accumulated on top of the reactor by the microbubbles as well as those in the reactor effluent were measured for example 1 and comparative example 1. The surface loading rates (the ratio of the surface of the precipitation tank to which the sludge is introduced to the amount of sludge introduced per hour) were similar for both examples with $0.21 \text{ g/cm}^2 \text{ hr}$ for example 1, and $0.23 \text{ g/cm}^2 \text{ hr}$ for comparative example 1.

In example 1, the concentration of the accumulated sludge was 14,660–23,400 mg/L and that in the reactor effluent was 3–10 mg/L. In comparative example 1, it was 18,760–26,760 mg/L for the accumulated sludge and 4–10 mg/L for the effluent sludge. The air/solid (A/S) ratios (related to sludge flotation efficiency) were similar in both examples with 0.004–0.009 for example 1, and 0.005–0.01 for comparative example 1. In other words, large amounts of pollutants were separated by air-flotation in both examples. In comparative example 1, however, scale accumulated on the electrode plates when the reactor was run over a long time. This led to fewer microbubbles generated and a diminished flotation capacity, which was shown in the increase in the amount of suspended solids (SS) in the effluent up to about 90 mg/L. Satisfactory observance of the effluent water quality standards is difficult in such situation.

As shown above, electrode plates should be regularly replaced in the case of comparative example 1 so as to prevent the decrease in flotation capacity caused by scale deposits on the electrode plates. This adds up to the maintenance and running costs for the method used in comparative example 1. In fact, the yearly running and maintenance costs including electricity bills for a reactor with a capacity of 100 tons/day according to comparative example 1, amount to 3,543,000 Korean Won with a 3-month replacement schedule for the electrode plates. This is approximately 4.5times the yearly running and maintenance costs for a corresponding reactor according to example 1, which is 789,000 Korean Won.

【Industrial Applicability】

The inventive ceramic diffuser, due to its manufacturing process with applied vibration under pressure, is capable of achieving a particle size distribution in which the sizes of silica or alumina particles increase in the direction towards the center with particles on the surface being the smallest. Thus a small air pressure around 1 atm is capable of providing a uniform and steady stream of microbubbles for securing a rapid flotation of pollutants in wastewater. In addition, the air-flotation method of the present invention does not suffer from scale formation as is the case with electro-flotation with electrode plates. This allows the inventive ceramic diffuser to be used conveniently and semi-permanently without maintenance problems, adding to its economic advantage. Furthermore, the enhanced productivity arising from the use of the inventive extrusion molding process for producing said ceramic diffusers supports additional cost reduction.

【CLAIMS】**【Claim 1】**

A ceramic diffuser based on silica or alumina capable of generating microbubbles, for separating wastewater pollutants through air-flotation, wherein said ceramic diffuser is a calcined silica or alumina powder compact.

【Claim 2】

The ceramic diffuser according to Claim 1, wherein the particle size distribution of said diffuser is such that the particle size increases in the direction toward the center of said ceramic diffuser with the sizes of particles on the surface of said diffuser being the smallest.

【Claim 3】

The ceramic diffuser according to Claim 1, wherein the pore size of said diffuser is in the range of 0.001-0.05 μm .

【Claim 4】

The ceramic diffuser according to Claim 1, wherein said ceramic diffuser is a disc or a pipe.

【Claim 5】

The ceramic diffuser according to Claim 1, wherein said ceramic diffuser is a pipe with a length in the range of 16-100 cm.

【Claim 6】

The ceramic diffuser according to Claim 1, wherein the size of microbubbles generated by said diffuser is in the range of 1-100 μm .

【Claim 7】

The ceramic diffuser according to Claim 1, wherein the size of microbubbles generated by said diffuser is in the range of 40-60 μm .

【Claim 8】

A method for producing pipe-shaped ceramic diffusers based on silica or alumina capable of generating microbubbles comprising:

- (a)preparing a wet powder of silica or alumina;
- (b)feeding a extruder with the wet powder;
- (c)placing a vibrator at the nozzle of said extruder;

- (d)applying vibration under pressure to the wet powder in the extruder using the vibrator to form an extrusion molded product; and
- (e)removing the extrusion molded product out of said nozzle and calcining said extrusion molded product in an oxidative atmosphere furnace.

【Claim 9】

The method according to Claim 8, wherein the pressure applied is in the range of 300 to 600 tons.

【Claim 10】

A method for producing disc-shaped ceramic diffusers based on silica or alumina capable of generating microbubbles comprising:

- (a)preparing a wet powder of silica or alumina;
- (b)feeding concave metallic mold 1 with the wet powder;
- (c)inserting a polyvinyl chloride film to the fed wet powder after the feeding;
- (d)feeding said concave metallic mold 1 with the wet powder on top of the inserted film;
- (e)leveling the top surface of the fed wet powder after the second feeding;
- (f)pre-molding the fed wet powder by driving convex metallic mold 2 into said wet powder with pressure;
- (g)applying vibration under pressure to the pre-molded wet powder using the supersonic vibrator 11 placed at least at one of the molds 1 and 2 to form a molded product; and
- (h)removing the molded product from said molds 1 and 2 and calcining said molded product in an oxidative atmosphere furnace.

【Claim 11】

The method according to Claim 10, wherein said film has a thickness in the range of 0.25-0.5 mm.

【Claim 12】

The method according to Claim 10, wherein said supersonic vibrator(s) 11 is/are placed either (a)inside said convex metallic mold 2 or (b)inside support 22 which said concave metallic mold 1 is fixed thereto or (c)one each

at both said places of (a) and (b).

【Claim 13】

The method according to Claim 12, wherein vibration separator(s) 12 is/are placed either (a)at the vicinity of said supersonic vibrator 11 and said support 22 wherein said supersonic vibrator 11 is fixed thereto or (b)at the vicinity of press 23 and the supersonic vibrator 11 inside said convex metallic mold 2 or (c)one each at both said places of (a) and (b) so as to block the propagation of the vibration toward said support 22 and the press 23.

【Claim 14】

The method according to Claim 10, wherein the removal of the molded product comprises a movement by piston 21 connected to an actuator capable of vertically moving up and down.

【Claim 15】

The method according to Claim 10, wherein the driving pressure of said convex metallic mold 2 is in the range of 100 to 200 tons and wherein said pressure applied with vibration is in the range of 10 to 30 tons.

【Claim 16】

Any one of the methods according to Claims 8-15, wherein the temperature of said oxidative atmosphere furnace is in the range of 900-1,300 °C.

【Claim 17】

Any one of the methods according to Claims 8-15, wherein said wet powder is a mixture of binder solution with either a silica or alumina powder which said ceramic diffuser is based thereon.

【Claim 18】

Any one of the methods according to Claims 8-15, wherein said vibration is applied at a frequency range of 20,000 to 25,000 hertzes.

【Claim 19】

A method for treating wastewater by air-flotation wherein microbubbles generating from any one of said ceramic diffusers according to Claims 1-7

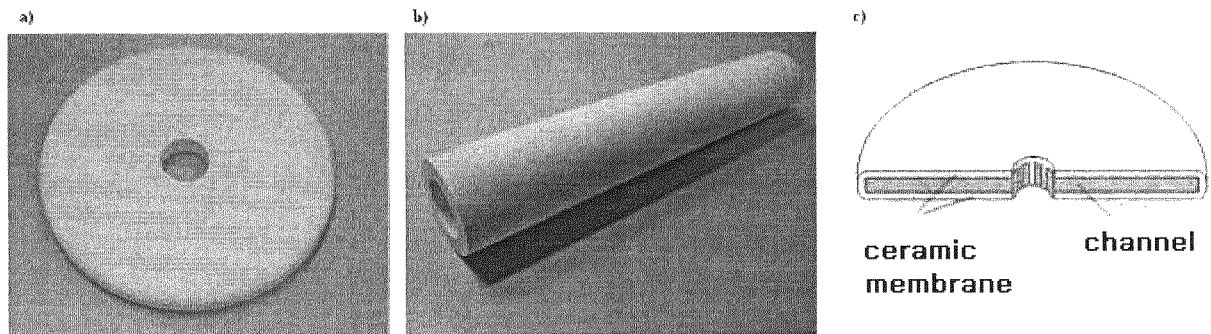
float pollutants to form concentrated sludge layer on the upper part and a layer of treated water on the lower part of a treatment cell.

【Claim 20】

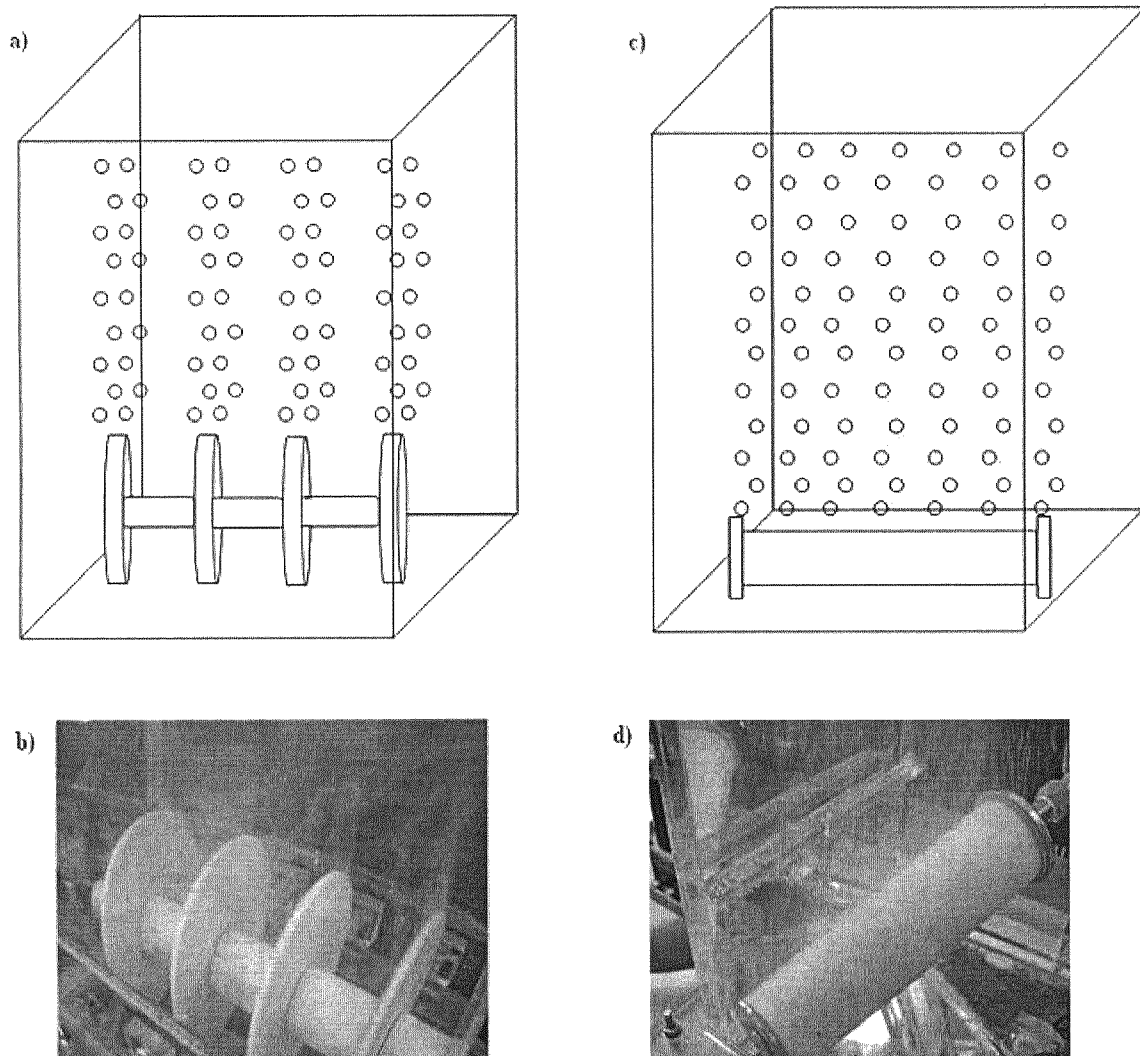
The method according to Claim 19, wherein aeration through said ceramic diffuser is achieved under a pressure of 0.8-1.2 atmospheres.

【DRAWINGS】

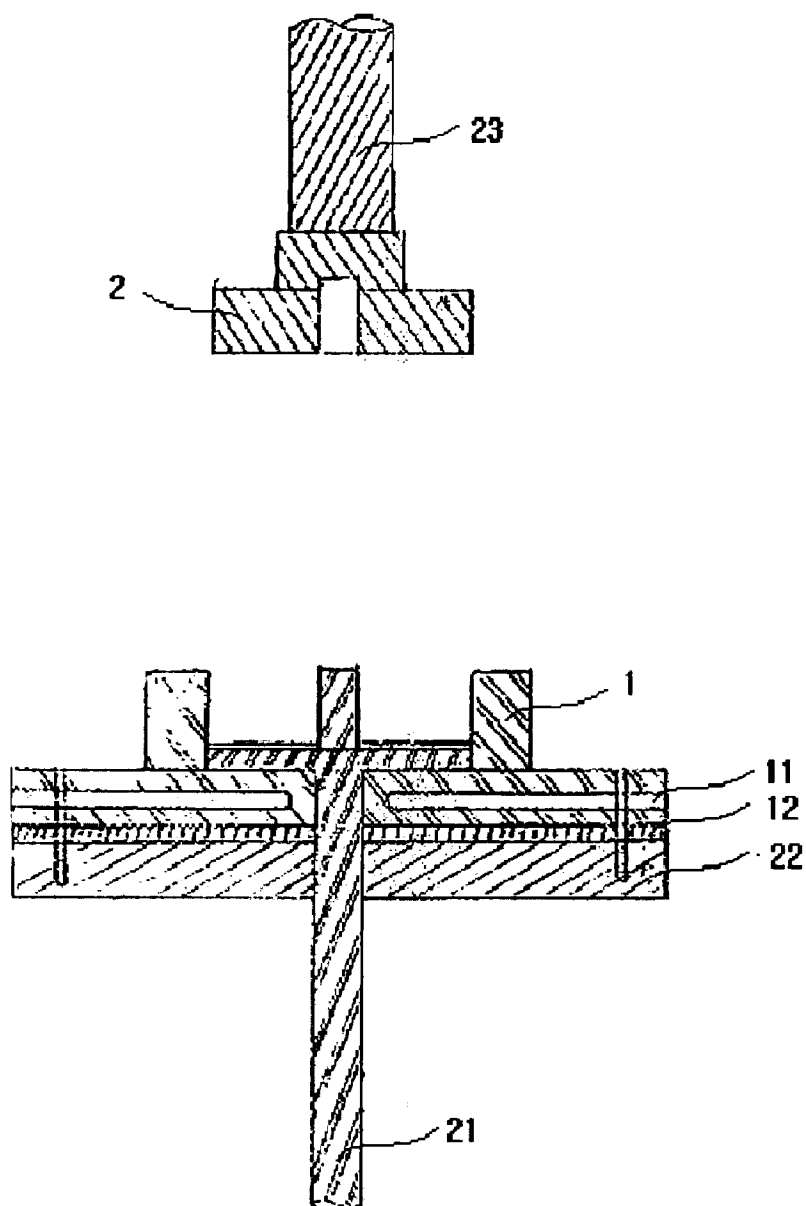
【Figure 1】



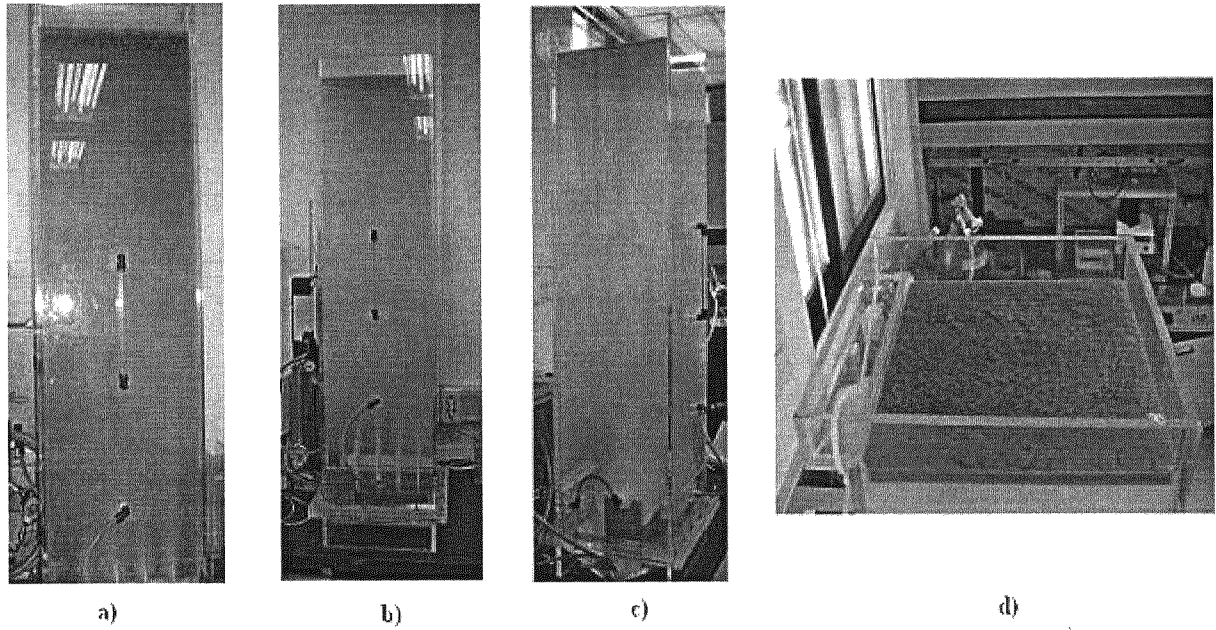
【Figure 2】



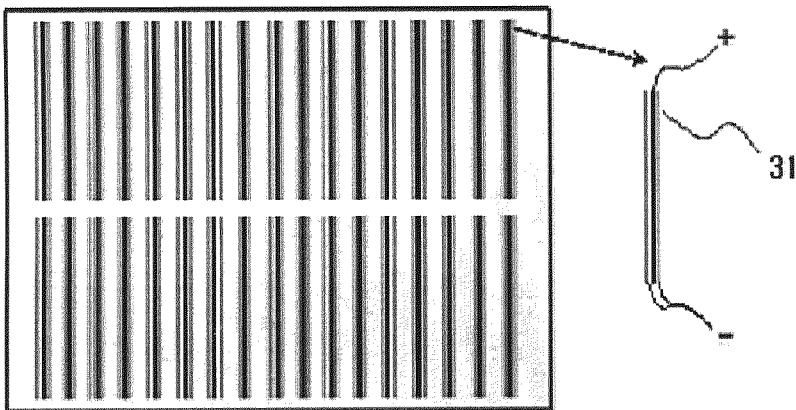
【Figure 3】



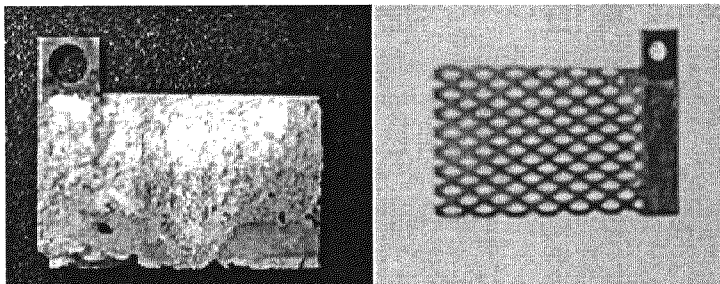
【Figure 4】



【Figure 5】



【Figure 6】



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2007/000261**A. CLASSIFICATION OF SUBJECT MATTER***C02F 3/20(2006.01)i*

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8 C02F, B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility Models and applications for Utility Models since 1975

Japanese Utility Models and applications for Utility Models since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS(KIPO internal)"keyword: silica powder, alumina powder, molding product, plasticity, floatation, ceramic diffuser, microbubble"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y ----- A	KR10-0173542 B1 (SSANGYONG CEMENT INDUSTRIAL CO., LTD.) 01 FEBRUARY 1999 See page 2 lines 42-59, and pages 3 lines 1-8	1, 4 ----- 2, 3, 5-20
Y ----- A	US4,832,847 A (NIPPON STEEL CO., LTD.) 23 MAY 1989 See column 2 lines 10-19	1, 4 ----- 2, 3, 5-20
A	KR10-1997-0065457 A (SSANGYONG CEMENT INDUSTRIAL CO., LTD.) 13 OCTOBER 1997 See abstract, and claim (1, 6)	1 - 20



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search

23 APRIL 2007 (23.04.2007)

Date of mailing of the international search report

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Telephone No. 82-42-481-8401



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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KR10-1997-0065457 A	13.10.1997	NONE	