

TECHNICAL FIELD

10 BACKGROUND ART

U.S. patent No. 5,653,129, (issued to Byung-Kew Jang on August 5, 1997) discloses a bubble automatic washing machine, which has a bubble generating means and an ozone generating means connected to each other in parallel.

FIG. 1 shows a conventional bubble automatic washing machine 100 with a bubble generating means and an ozone generating means connected to each other in parallel, described in the U.S. patent No. 5,653,129.

5 The washing machine 100 includes a housing 102 and a stationary washer tub 104 fixedly mounted within housing 102 for containing a level of washing fluid therein. Pulsator 106 is rotatable in a forward or reverse direction to create a vortex flow within rotatable tub 112.

10 The top of washing machine 100 is provided with a door 108 for loading and unloading the laundry articles. Bubble generating means 110 is mounted on the inner surface of door 108 to extend toward rotatable tub 112. Bubble generating means 110 is shown in FIG. 2 in detail. An air pump 116 is
15 communicated with bubble generating means 110 through an air conduit 114. In the drawings, air pump 116 is installed at the bottom plate of washing machine 100 but may be installed at any other suitable place.

 Bubble generating means 110 includes a telescopic pipe
20 202 which is movable upward and downward, and driver 204 for actuating telescopic pipe 202. Though 3-stage telescopic pipe 202 is shown in the drawings, the number of stages is not specially limited as long as the washing machine operates smoothly.

25 Telescopic pipe 202 is fixed to a casing 218 of driver 204 coaxially with rotatable tub 124. Casing 218 is fixed to the inner surface of door 108 and a DC motor 206 is installed to casing 218. A driving shaft 208 of DC motor 206 is operatively connected to a first pulley 210 which is
30 operatively connected to a second pulley 214 through a belt 212.

 Second pulley 214 has a groove for belt 212 and gear teeth formed separately, and a flexible plastic string 216 is wound on the gear teeth. A train of teeth is formed on flexible
35 plastic string 216 to mesh with the gear teeth. Flexible

plastic string 216 has a suitable flexibility for being forced to expand and withdraw telescopic pipe 202.

Flexible plastic string 216 extends within, via a hole 219 formed to casing 218, an inner telescopic pipe 220 which is coaxially installed inside the inner telescopic pipe 202 and has the top end fixed to casing 218. The end of flexible plastic string 216 is fixed to the lower end of inner telescopic pipe 220 which is fixed to the lower end of telescopic pipe 202.

The lowest stage of telescopic pipe 202 is provided with a plurality of spurt holes 222 to create air bubbles. Air conduit 114 extends through casing 218 and communicates with inside of telescopic pipe 202. A space between telescopic pipe 202 and inner telescopic pipe 220 serves as an air passage and the air flowing out of air conduit 114 blows into rotatable tub 112, sequentially passing through the space and spurt holes 222.

An ozone generating means 118 may be further installed between air pump 116 and driver 204 in order to kill bacteria inhabiting the laundry articles. As a result, ozone is contained in air bubbles blowing into rotatable tub 124 to remove bacteria from the laundry articles.

Moreover, a heater 120 may be installed between ozone generating means 118 and driver 204 in order to create a hot air stream for drying the laundry articles. The air stream generated from air pump 116 flows through air conduit 114 to heater 120 to heat up and is transmitted to the laundry articles within rotatable tub 112.

However, a conventional bubble automatic washing machine with the bubble generating means and the ozone generating means connected to each other in parallel has drawbacks, e.g., installation space is occupies a large area and oxygen (O_2) through the bubble generating means has low degree of generating efficiency of an ozone. In order to get force of washing and cleaning for proper washing is a large

amount of ozone is indispensable as well. As a result, induced ozone has the disadvantage of inflict bodily harm due to the high concentration and bad odor of ozone itself.

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DISCLOSURE OF INVENTION

Therefore, it is an object of the present invention, for the purpose of solving the above mentioned problems, to
10 provide a radical generating system which integrates a bubble generating means, an ozone generating means, and a radical changing means.

In order to attain the object, according to the present invention, there is provided a radical generating system
15 comprising:

- a bubble generating means for generating an air bubbles;
- an ozone generating means for generating an ozone introduced from the bubble generating means;

- a radical changing means for changing the ozone which is
20 introduced from the ozone generating means into a first active oxygen radical; and

- a housing having the bubble generating means, the ozone generating means, and the radical changing means all formed integrally.

25 Other objects and further features of the present invention will become apparent from the detailed description when read in conjunction with the attached drawings.

BRIEF DESCRIPTION OF DRAWINGS

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Other features and advantages of the present invention will become more apparent from the following description taken in connection with the accompanying drawings, wherein:

FIG. 1 is a schematic sectional view for showing a
35 conventional bubble washing machine having bubble and ozone

generating means connected to each other in parallel;

FIG. 2 is an enlarged sectional view of the bubble generating means shown in FIG. 1;

FIG. 3 is a plan view for showing a radical generating system according to a preferred embodiment of the present invention;

FIG. 4 is a side end view of the bubble generating means taken along line A-A shown in FIG. 3; and

FIG. 5 is a view for illustrating a principle of an operation of the bubble generating means shown in FIGs. 3 and 4.

BEST MODE FOR CARRYING OUT THE INVENTION

The preferred embodiment of the present invention will hereinafter be described in detail with reference to the accompanying drawings.

FIG. 3 shows a radical generating system 300 according to a preferred embodiment of the present invention. The radical generating system 300 includes a bubble generating means 302, an ozone generating means 304, a radical changing means 308, a housing 310, a first check valve 311, and a second check valve 313.

FIG. 4 is a side end view of the bubble generating means 302 taken along line A-A shown in FIG. 3. FIG. 5 illustrates a principle of an operation of the bubble generating means 302 shown in FIGs. 3 and 4.

The bubble generating means 302 generates air for generating air bubbles. The bubble generating means 302 includes an air pump 312 and an operating section 314. The air pump 312 pumps the air for generating air bubbles and ozone.

The air pump 312 includes a diaphragm 312a fixed to the operating section 314. The diaphragm 312a expands by means of up and down motion of the operating section 314 and expands and contracts volume of a pump chamber 312b formed therein. The diaphragm 312a is formed with a resilient material such

as rubber capable of contracting or expanding by an external force. An air pump body 312d is installed apart from valve sheet 312c at a predetermined distance. The air pump body 312d includes an air inlet 312e for introducing external air to the pump chamber 312b by compression and contraction of the diaphragm 312a. The air pump body 312d includes an air outlet 312f for discharging the air in the pump chamber 312b to the gas mixing chamber 306. The air introduced through the air inlet 312e is guided into the pump chamber 312b which is defined by the diaphragm 312a and the air pump body 312d through a first hole 312g. The air compressed in the pump chamber 312b is discharged to the air outlet 312f through a second hole 312h.

The operating section 314 compresses and returns the air pump 312 according to current supply. The operating section 314 includes an electromagnet 314a, a magnet 314b, and an operating member 314c. The electromagnet 314a generates magnetic field according to current supply. The magnet 314b vibrates according to the magnetic field generated by the electromagnet 314a. The operating member 314c moves up and down according to the vibration of the magnet 314b.

As shown in FIG. 5, the bubble generating means 302 uses a principle of the electromagnet 314a. When 100 ~ 250V/50 ~ 60Hz power is applied to a coil-wound core, a phase of the electromagnet 314a changes thereby changing polarity of the magnetic field generated around surface of the core. Accordingly, the phenomenon which pushes and pulls the magnet 314b repeats and oscillates sixty times per second. The magnet 314b which oscillates at 10 Hz compresses and returns the air pump 312 so that the pumping operation is performed through the diaphragm 312a.

The ozone generating means 306 applies high voltage to the air for generating air bubbles, and ozone is a triatomic allotrope of oxygen in which the ozone molecule consists of three oxygen atoms in contrast to the two oxygen atoms which

have the typical oxygen molecule. Ozone can be generated by passing air or oxygen through a high intensity electric field.

The radical changing means 308 is disposed in the housing 302 and communicates with the gas mixing chamber 306. The radical changing means 308 has a active oxygen radical generating catalyst for changing a first-series active oxygen catalyst ($\cdot\text{O}$, $\cdot\text{O}^-$, $^1\text{A}_g\text{O}_2$, and O_2^- , etc.) from the ozone. The first-series active oxygen radical generates a second-series active oxygen radical ($\text{OH}\cdot$, OH^- , $\text{HO}_2\cdot$, HO_2^- , and H_2O_2 , etc.) that reacts to a water molecule. The second-series active oxygen radical comprises the strongest hydroxyl ($\text{OH}\cdot$).

The radical changing means 308 comprises an active oxygen radical generation catalyst 308a, and a catalyst chamber 308b. The active oxygen radical generation catalyst 308a includes a main catalyst, a sub catalyst, and a catalyst support. The main catalyst has one of TiO_2 , MnO_2 , and CuO_2 . The sub catalyst has either Pt, or Pd. The catalyst support has one of Al_2O_3 , SiO_2 , and MgO .

The catalyst chamber 308b comprises a hollow 308i, a left side wall 308c, and a right side wall 308e. The hollow 308i forms a hexahedron. The left side wall 308c has inlet 306a of ozone introduced from the ozone generating means 304. The right side wall 308e has outlet 306b of first-series active oxygen radical introduced from the radical changing means 308. The catalyst chamber 308b further comprises a first separate membrane 308g and a second separate membrane 308h. The first separate membrane 308g is installed at the inner surface of the hollow 308i between the ozone inlet 308d and the radical outlet 308f. The second separate membrane 308h is installed at the inner surface of the hollow 308i between the first separate membrane 308g and the radical outlet 308f.

The housing 310 has the bubble generating means 302, the ozone generating means 304, and the radical changing means

308 all formed integrally.

The first check valve 311 is mounted between the bubble generating means 302 and the gas mixing chamber 306. The first check valve 311 selectively introduces the air for generating
5 air bubbles from the bubble generating means 302 to the ozone generating means 304. The first check valve 311 serves to prevent the supply of air for generating air bubbles and from the bubble generating means 302 from flowing inversely.

The second check valve 313 is mounted between the gas
10 mixing chamber 306 and the radical changing means 308. The second check valve 313 selectively introduces the air for generating air bubbles from the ozone generating means 304 to the radical changing means 308. The second check valve 313 serves to prevent the supply of air for generating air bubbles
15 from the ozone generating means 304 from flowing inversely.

Hereinafter, an operation of the radical generating system 300 according to a preferred embodiment of the present invention will be described.

When current is applied to the electromagnet 314a of
20 operating section 314 of the bubble generating means 304, the electromagnet 314a generates a magnetic field. The magnet 314b vibrates according to the magnetic field generated by the electromagnet 314a. The operating member 314c moves up and down according to the vibration of the magnet 314b.

25 The diaphragm 312a of air pump 312 expands by means of up and down motion of the operating member 314c and expands and contracts volume of a pump chamber 312b formed therein to thereby pump the air for generating air bubbles.

The first check valve 311 injects the air for generating
30 air bubbles from the bubble generating means 302 to the gas mixing chamber 306 so that the gas mixing chamber 302a stores the air for generating air bubbles. The ozone generating means 304 applies high voltage to the air for generating air bubbles and ozone stored in the gas mixing chamber 306 in order
35 to produce ozone.

The second check valve 313 injects the air for generating air bubbles from the ozone generating means 304. The ozone decomposes the first-series active oxygen catalyst by an active oxygen radical generating catalyst 308a which is included in the radical changing means 308. And then the ozone goes past the first separate membrane 308g and the second separate membrane 308h in sequence. As contact time and flow distance of the ozone is extended, the ozone forms vortex and the radical changing means 308 improves of the generating efficiency of the ozone.

The first-series active oxygen radical which induce the second-series active oxygen radical react with water molecule and hydrogen. The oxidizing power is strongest to weakest in order from $F_2(2.87\text{eV}) > OH\cdot \text{ Radical}(2.85\text{eV}) > O_3(2.07\text{eV}) > H_2O_2(1.78\text{eV}) > Cl_2(1.36\text{eV})$. Thus hydroxyl radical of the second-series active oxygen radical characterizes a second strongest oxidizing power and rapid oxidizing reaction. The radicals rapidly react and disappear to the ozone.

The strong oxidizing action of the first-series active oxygen radical and the second-series active oxygen radical effectively sterilizes bacilli such as bacteria, viruses, mold, fungi, or algae which live in the air, water, and solid material. That is, the radicals attack protoplasm membrane of a fungus and it is sterilized by the lysis.

A deodorizing process for the radicals is differs from chemical conversion process according to induction material of the odors. But radicals of aromatic compounds, for example, break $C=C$ bond so that induction ingredient of the odors convert the molecular structure to become odorless.

Effects of the radical generating system according to the present invention as constructed above will be described below.

The radical generating system according to the present invention sterilizes bacilli such as bacteria, viruses, mold,

fungi, or algae which live in washing water or clothes. The present invention also improves washing effect of a washing machine by oxidizing and bleaching actions of the first-series active oxygen radical and the second-series active
5 oxygen radical.

The radical generating system has a sterilizing/deodorizing effect to prevent a reduction the sterilizing efficiency and environmental pollution by the additive ingredient such as a solid material which is
10 maintained based on the application time of the ingredient having oxide power. The radical generating system has a high degree of efficient sterilization and deodorization in comparison with the ozone generating means, so no unpleasant odor nor harm occurs.

15 A radical generating system of the present invention can be applied a various fields and products such cleaning beds, water purifier, sewage purification, drainage treatment, washing machine, refrigerator, humidifier, and cleaning machine, etc.

20 The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being
25 indicated by the appended claims rather than by the foregoing description and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.



CLAIMS

1. A radical generating system comprising:
a bubble generating means for generating an air bubbles;
5 an ozone generating means for generating an ozone introduced from the bubble generating means;
a radical changing means for changing the ozone which is introduced from the ozone generating means into a first active oxygen radical; and
10 a housing having the bubble generating means, the ozone generating means, and the radical changing means all formed integrally.
2. The radical generating system according to claim 1,
15 wherein the radical changing means further comprises:
a catalyst chamber having a hollow formed as a hexahedron, a left side wall having inlet for ozone introduced from the ozone generating means, a right side wall having outlet of first-series active oxygen radical
20 introduced from the radical changing means; and
an active oxygen radical generation catalyst stored in the hollow in order to introduce the first-series active oxygen radical from the ozone.
- 25 3. The radical generating system according to claim 2, wherein the active oxygen radical generation catalyst comprises:
a main catalyst having one of TiO_2 , MnO_2 , and CuO_2 ;
a sub catalyst having either Pt, or Pd; and
30 a catalyst support having one of Al_2O_3 , SiO_2 , and MgO .
4. The radical generating system according to claim 2, wherein the catalyst chamber further comprises:
a first separate membrane installed at the inner surface
35 of the hollow between the ozone inlet and the radical outlet;



and

a second separate membrane installed at the inner surface of the hollow between the first separate membrane and the radical outlet.

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5. The radical generating system according to claim 2, wherein the first-series active oxygen radical introduces a second-series active oxygen radical which reacts to water molecule and hydrogen of water and air.

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6. The radical generating system according to claim 2, wherein the ozone generating means applies high voltage to the air for generating air bubbles stored in the gas mixing chamber in order to produce ozone.

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7. A washing machine comprising:

a bubble generating means for applying high voltage to air bubbles and pumping;

an ozone generating means for generating ozone introduced from the bubble generating means; and

a radical changing means for changing the first-series active oxygen radical introducing a second-series active oxygen radical which reacts to water molecule and hydrogen of water and air, wherein the radical changing means includes

a catalytic chamber having a hollow formed as a hexahedron, a left side wall having inlet for ozone introduced from the ozone generating means, a right side wall having outlet of first-series active oxygen radical introduced from the radical changing means; and

an active oxygen radical generating catalyst stored in the hollow in order to introduce the first-series active oxygen radical from the ozone comprising a main catalyst having one of TiO_2 , MnO_2 , and CuO_2 , a sub catalyst having either Pt or Pd, and a catalyst support having one of Al_2O_3 , SiO_2 , and MgO .