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(54) **Title:** WATER PURIFIER AND METHOD OF DETERMINING THE PERFORMANCE OF A WATER PURIFYING SYSTEM

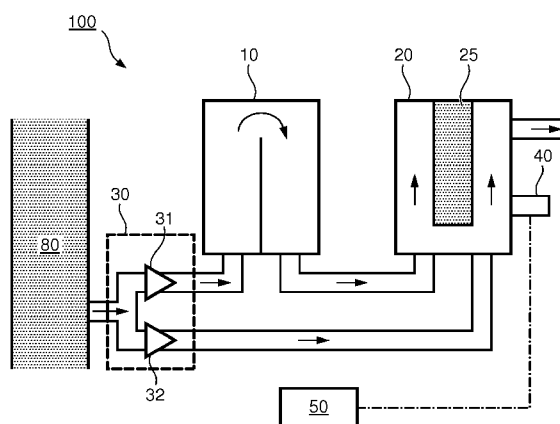


FIG. 1

(57) **Abstract:** The invention relates to a water purifier and a method of determining the performance of a water purifying system, said water purifier comprising: a purifying chamber (10) for purifying water coming from a water source (80); a reactor (20) comprising a UV lamp (25) for disinfecting water flowing through said reactor (20); a switch unit (30) adapted to take a first position to allow water coming from said water source to flow through said purifying chamber (10) and to fill said reactor (20), and adapted to take a second position to allow water coming from said water source to bypass said purifying chamber and fill said reactor; a sensor (40) configured to obtain the light intensity of the light beam emitted by said UV lamp (25) after said light beam has passed through water in said reactor; and a processor (50) adapted to: obtain a first light intensity from said sensor, when said switch unit is in said first position; obtain a second light intensity from said sensor, when said switch unit is in said second position; and determine the performance of said purifying chamber on the basis of said first light intensity and said second light intensity.



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WATER PURIFIER AND METHOD OF DETERMINING THE PERFORMANCE OF A WATER PURIFYING SYSTEM

FIELD OF THE INVENTION

The invention relates to a water purifier and a method of determining the performance of a water purifying system.

The invention may be used in the field of water purification.

BACKGROUND OF THE INVENTION

In many countries, the quality of tap water is insufficient for drinking. This creates a market for domestic water purifiers that remove harmful contaminants from the tap water. Customers would like the quality of the water from the purifier to be guaranteed. This can be achieved by choosing the proper treatment technology. Most domestic purifiers include a purifying chamber, for example, a filter. However, filters have to be replaced in due time to ensure purifying efficiency. For some products employing UV (ultraviolet ray) disinfection, UV lamp performance also has to be monitored.

In some existing solutions, a predetermined time or a predetermined amount of filtered water is used as indicator for filter replacement. However, these indicators are not very accurate, since water quality impacts the life cycle of the filter. The more contaminants or organic matter present in water, the more contaminants may be left in the filter, and the shorter the life of the filter will be. That is to say, the filter may be overused, which may affect users' health, or underused, causing it to be unnecessarily wasted.

According to some other solutions, specialized monitoring elements are adopted for more accurate detection of performance of the filter. However, specialized monitoring elements are always large, expensive, and not appropriate for home use.

Some water purifying systems comprise both a purifying chamber and a UV lamp. The purifying chamber is adopted for purifying water from a water source. The UV lamp is

adopted for disinfecting water coming from the purifying chamber. The intensity of the UV light passing through the water is detected and used to indicate the quality of the purified water. In fact, the performance of both the purifying chamber and the UV lamp impacts the quality of purified water, but there is no low-cost, simple-structure solution in the prior art as to how performance degradation of the purifying chamber and the UV lamp can be detected in such a water purifying system.

OBJECT AND SUMMARY OF THE INVENTION

UV absorption can also be used to monitor the performance of the purifying chamber. A higher UV absorption of purified water indicates that the water quality leaves to be desired, and corresponds to a sub-optimal performance of the purifying chamber. Thus, the performance of the purifying chamber can be determined by comparing the UV light intensity of purified water with a known UV light intensity of “reference water”. The known UV light intensity of “reference water” can be the UV light intensity of known “good water” (e.g. water that has passed through a calibrated filter) or the UV light intensity of water without purification by the purifying chamber. Thus, it is an object of the invention to propose a water purifier comprising a UV lamp which is adapted to disinfect water from the purifying chamber and to monitor the performance of elements of the water purifier.

To this end, the water purifier according to the invention comprises:

- a purifying chamber for purifying water coming from a water source;
- a reactor comprising a UV lamp for disinfecting water flowing through said reactor;
- a switch unit adapted to take a first position to allow water coming from said water source to flow through said purifying chamber and to fill said reactor, and adapted to take a second position to allow water coming from said water source to bypass said purifying chamber and fill said reactor,
- a sensor configured to obtain the light intensity of the light beam emitted by said UV lamp after said light beam has passed through water in said reactor; and
- a processor adapted to:
 - obtain the first light intensity from said sensor, when said switch unit is in said first position;

obtain the second light intensity from said sensor, when said switch unit is in said second position; and

determine the performance of said purifying chamber on the basis of said first light intensity and said second light intensity.

By virtue of the improved structure of the water purifier, the performance of the purifying chamber is monitored more accurately and timely. Thus, when the purifying chamber has reached the end of its life cycle it can be replaced immediately, so that the quality of processed water from this kind of water purifier is better and more stable than that from existing water purifiers. Furthermore, the structure of the water purifier is simple, since only one UV lamp is used for a number of purposes, which makes the water purifier low-cost and appropriate for home use.

The invention also relates to a method of determining the performance of a purifying chamber in a system, said system also comprising a reactor with a UV lamp for disinfecting water flowing through said reactor, said purifying chamber being in fluid communication with said reactor, said method comprising the steps of:

a. obtaining a first light intensity of the light beam emitted by said UV lamp after said light beam has passed through water which comes from a water source and which passes through said purifying chamber in said reactor;

b. obtaining a second light intensity of the light beam emitted by said UV lamp after said light beam has passed through water which comes from said water source but which does not pass through said purifying chamber in said reactor; and

c. determining the performance of said purifying chamber on the basis of said first light intensity and said second light intensity.

The invention further relates to a method of detecting the performance of a UV lamp in a water purifying system, which UV lamp is adapted for disinfecting water flowing through a reactor, said method comprising the steps of:

A. obtaining a reference light intensity of a light beam emitted by said UV lamp after said light beam has passed through water which comes from a water source, in said reactor;

B. obtaining an updated light intensity of the light beam emitted by said UV lamp after said light beam has passed through water which comes from said water source, in said reactor;

C. determining the performance of said UV lamp on the basis of said reference light intensity and said updated light intensity.

Detailed explanations and other aspects of the invention will be given below.

BRIEF DESCRIPTION OF THE DRAWINGS

The particular aspects of the invention will now be explained with reference to the embodiments described hereinafter and considered in connection with the accompanying drawings, in which identical parts or sub-steps are designated in the same manner:

Fig.1 depicts a water purifier according to the invention,

Fig. 2 depicts the variation curve of the QSD of a water purifier against the volume of water purified by the purifying chamber according to an embodiment of the invention,

Fig.3 depicts another water purifier according to the invention,

Fig.4 depicts a method according to the invention of determining the performance of a purifying chamber in a system,

Fig.5 depicts a method according to the invention of detecting the performance of a UV lamp in a water purifying system.

DETAILED DESCRIPTION OF THE INVENTION

Fig.1 depicts a water purifier 100 according to the invention. The water purifier 100 comprises:

- a purifying chamber 10 for purifying water coming from a water source 80;
- a reactor 20 comprising a UV lamp 25 for disinfecting water flowing through said reactor 20;
- a switch unit 30 adapted to assume a first position to allow water coming from said water source 80 to flow through said purifying chamber 10 and fill said reactor 20, and adapted to assume a second position to allow water coming from said water source 80 to bypass said purifying chamber 10 and fill said reactor 20,
- a sensor 40 configured to obtain a light intensity of the light beam being emitted by said UV lamp 25 and passing through water in said reactor 20; and

- a processor 50 adapted to:

obtain a first light intensity from said sensor 40, when said switch unit 30 is in said first position;

obtain a second light intensity from said sensor 40, when said switch unit 30 is in said second position; and

determine the performance of said purifying chamber 10 on the basis of said first light intensity and said second light intensity.

For example, the purifying chamber 10 comprises a filter capable of removing contaminants, such as a carbon filter. Water flowing through the purifying chamber 10 will be purified by the carbon filter.

In another example, the purifying chamber 10 comprises an oxidation reactor. Water flowing through the purifying chamber 10 will be purified by oxidation reaction, for example making use of ozone (O_3) or hydrogen peroxide (H_2O_2) as oxidant, or other hydroxy radical-based oxidation reaction.

When the water purifier 100 is connected to the water source 80, the purifying chamber 10 is in fluid communication with the water source 80 and the reactor 20, respectively, and the reactor 20 is also in fluid communication with the water source 80 bypassing the purifying chamber 10. For example, the fluid communication is achieved by means of pipes between the water source 80, the purifying chamber 10 and the reactor 20.

For example, the water source 80 may correspond to tap water or water stored in a tank. In the case that the water source 80 corresponds to water stored in a tank, the water purifier 100 may further comprise a pump (not shown), or the water purifier 100 may be disposed below the tank, so that the force of the pump or the potential difference could cause water to flow through the water purifier 100 along the paths generally indicated by the arrows. In the case that the water source 80 corresponds to tap water, the hydraulic pressure of tap water could cause water to flow through the water purifier 100 along the paths generally indicated by the arrows.

In an embodiment as illustrated in Fig.1, the switch unit 30 comprises a first switch (valve) 31 and a second switch (valve) 32. The first switch 31 is in the path between the water source 80 and the purifying chamber 10, while the second switch is in the path between the water source 80 and the reactor 20. When the switch unit 30 is in the first position, the first switch 31 is open and the second switch 32 is closed, such that water coming from the water source 80 will flow through the purifying chamber 10 and fill the reactor 20. When the switch unit 30 is in the second position, the first switch 31 is closed and the second switch 32 is open, such that water coming from the water source 80 will bypass the purifying chamber 10 and fill the reactor 20.

In some other embodiments, the switch unit comprises a shunt valve with one inlet configured to be connected to a water source and two outlets connected to the purifying chamber and the reactor, respectively, such as, for example the switch unit 30a as shown in FIG.3. When the shunt valve is in the first position, the first outlet (e.g. the upper outlet shown in Fig.3) is open and the second outlet (e.g. the lower outlet shown in Fig.3) is closed, such that water coming from the water source 80a will flow through the purifying chamber 10a and fill the reactor 20a. When the shunt valve is in the second position, the first outlet is closed and the second outlet is open, such that water coming from the water source 80a will bypass the purifying chamber 10a and fill the reactor 20a.

The change of the position of the switch unit 30 may be controlled by the processor 50. Alternatively, a signal may be represented, for example by a display unit (not shown), to inform the user of the change in position of the switch unit 30.

The UV lamp 25 is used for disinfecting water flowing through the reactor 20. As shown in Fig.1, the UV lamp 25 is positioned at the centre of reactor 20, and omnidirectional UV light beams are emitted from this UV lamp 25. The UV light beams emitted by UV lamp 25 then pass through the water in reactor 20. Alternatively, the UV lamp 25 could also be located at any other feasible place, for example at an inner wall of the reactor 20. Thus, a directional UV light beam might be emitted towards water in the reactor 20, resulting in a higher emission efficiency and a lower power consumption. The UV light beams emitted by UV lamp 25 then pass through water in the reactor 20.

The sensor 40 is generally located in or around the reactor 20, such that the sensor 40 can receive light beams emitted by UV lamp 25 after these light beams have passed through water in the reactor 20. Thus, the sensor 40 can obtain the light intensity of the UV light beam emitted by the UV lamp 25 after the light beam has passed through water in the reactor 20.

In normal working conditions, the switch unit 30 switches between entirely closed and the first position, i.e. the second switch 32 is closed while the first switch 31 is open, so that water coming from the water source 80 is purified in the purifying chamber 10 and disinfected in the reactor 20, and then flows out of the water purifier 100.

Hereinafter, the obtained light intensity corresponding to purified water, i.e. the light intensity obtained when the switch unit 30 is in the first position and the water filled into the reactor 20 has passed through the purifying chamber 10 before entering reactor 20, is referred to as first light intensity. The obtained light intensity corresponding to unpurified water, i.e. the light intensity obtained when the switch unit 30 is in the second position and the water filled into the reactor 20 has not previously passed through the purifying chamber 10, is referred to as second light intensity. The processor 50 is adapted to obtain at least one first light intensity from the sensor 40 and at least one second light intensity from the sensor 40 and to determine the performance of the purifying chamber 10 on the basis of said at least one first light intensity and said at least one second light intensity.

According to Beer-Lambert law:

$$I = I_t 10^{-\alpha x} \quad (1).$$

The formula (1) can be rewritten as

$$\log I = \log I_t - \alpha x \quad (2),$$

wherein x is a distance which is fixed in the water purifier 100, I_t is intensity of UV light emitted from the UV lamp 25 at time t , I is the light intensity that can be measured by the sensor 40 and α is the UV absorption rate of the water in the reactor 20.

It is intelligible that the performance of the UV lamp 25 is considered invariable within a certain time interval. Said certain time period should be short enough to ensure that there is no

substantial difference between the measuring conditions of a first light intensity and a second light intensity. A first light intensity and a second light intensity, which are obtained one after another within a certain time interval t , could be expressed as

$$\log I_{1t} = \log I_t - \alpha_{1t} x \quad (3),$$

$$\log I_{2t} = \log I_t - \alpha_{2t} x \quad (4),$$

wherein I_{1t} and I_{2t} are light intensities captured by the sensor 40 when the reactor 20 is filled with purified water and unpurified water, respectively, within the certain time interval t ; α_{1t} and α_{2t} are UV absorption rates of purified water and unpurified water, respectively, within the certain time interval t . It could be obtained from formulas (3) and (4) that

$$\Delta \alpha_t = \alpha_{1t} - \alpha_{2t} = \frac{\log I_{1t} - \log I_{2t}}{x} \quad (5),$$

wherein $\Delta \alpha_t$ is the difference between the UV absorption rate of purified water and the UV absorption rate of unpurified water within the certain time interval t , which could be referred to as quasi-synchronous difference between UV absorption rates of purified water and unpurified water, QSD for short. It is intelligible that the QSD is strongly relevant to the performance of the purifying chamber 10 and substantially irrelevant to the performance of the UV lamp 25, since the performance of the UV lamp 25 could be considered as invariable within the certain time interval t and the influences from the UV lamp 25 cancel out in formula (5). Actually, the QSD represents the purification degree of the water passing through purifying chamber 10, which is a good indicator of the performance of the purifying chamber 10. The higher the QSD value, the better the performance of the purifying chamber 10 is.

The water purifier 100 may further comprise a display unit (not shown). When the processor 50 finds that the performance of the purifying chamber 10 is insufficient for regular purification, the display unit is controlled so as to show an indicator for indicating that the purifying chamber 10 needs to be replaced. In the case that the purifying chamber 10 comprises a carbon filter, the indicator may indicate that the carbon filter needs to be replaced. In the case that the purifying chamber 10 comprises an oxidation reactor, the indicator may indicate that the oxidation reactor needs to be supplied with oxidant.

With such a water purifier 100, the processed water is much safer to drink due to said purification and UV disinfection steps, and the performance monitoring is much more accurate due to the UV absorption detection technology, enabling elements with poor performance to be renewed in time, so that the quality of processed water is good and stable. Besides, the water purifier 100 is of comparatively low cost and small in size, because of the design of the multipurpose UV lamp and the use of only one UV sensor, which makes it more appropriate for home use.

In some variations of the above embodiment, the water purifier 100 further comprises a filter (not shown) in the path between the second switch 32 and the reactor 20. This filter is configured to filter water coming from the water source 80 before the water enters the reactor 20, wherein, if the switch unit 30 is in the second position, water flows through this filter before filling the reactor 20. This filter is only used for calibration. That is to say, water from this filter is deemed to be of good quality and is used as reference to determine the quality of other water. With the implementation of this filter, when the second light intensity is obtained, water bypassing the purifying chamber 10 and being filled into the reactor 20 has a stable quality.

In an embodiment of the invention, the purifying chamber 10 of the water purifier 100 comprises a carbon filter. Fig.2 depicts the variation curve of the QSD of such a water purifier 100 against the volume of water purified by the purifying chamber 10. As depicted in Fig.2, the QSD ($\Delta\alpha_t$) drops as the water volume purified by the filter in the purifying chamber 10 increases, so that its curve is similar to that of a negative exponential distribution. As mentioned above, the switch unit 30 switches between an entirely closed position and the first position in a normal working condition. It is intelligible that the second light intensity is unattainable in the normal working condition, thus, a preferred monitoring process is given hereinbelow.

First, there is an initialization phase, wherein a first light intensity I_{10} and a second light intensity I_{20} are obtained within a very short period of time since a new filter in the purifying chamber 10 is put into use, and are recorded for reference. To be specific, the switch unit 30 is initially set to the second position, so that the reactor 20 is flushed by and filled with water

coming from the water source 80 and bypassing the purifying chamber 10, thus enabling the reference second light intensity I_{20} to be obtained. After that, the switch unit 30 is switched to the first position, so that the water in the reactor 20 is replaced by water coming from the water source 80 and passing through the filter in the purifying chamber 10, thus enabling the reference first light intensity I_{10} to be obtained. Thus, the reference QSD could be obtained, i.e.

$$\Delta\alpha_0 = \frac{\log I_{10} - \log I_{20}}{x} \quad (6).$$

Then the water purifier 100 works in a normal working phase, so that water coming from the water source 80 will be purified in the purifying chamber 10 and disinfected in the reactor 20, and then flows out of the water purifier 100. A first light intensity will be obtained in accordance with a predetermined schedule, for example once every preset period of time or once every preset volume of water purified by the purifying chamber 10. The updated first light intensity is represented as I_{1t} . It could be derived from formula (3) that

$$\log I_{10} - \log I_{1t} = (\log I_0 - \log I_t) + (\alpha_{1t} - \alpha_{10})x \quad (7),$$

wherein I_0 is the intensity of UV light emitted from the UV lamp 25 during the initialization phase. As is known, the detected intensity of a UV light beam depends on the emission intensity of the UV lamp and the path loss, wherein the emission intensity is relevant to the performance of the UV lamp, while the path loss is relevant to the water quality and the travel distance of the UV light beam. Therefore, the difference between the reference first light intensity I_{10} and the updated first light intensity I_{1t} is relevant to the performance variation of the UV lamp and the variation of the water quality, wherein the variation of the water quality could be further attributed to the performance variation of the purifying chamber. Specifically, as represented in formula (7), the first part of $(\log I_0 - \log I_t)$ is relevant to the performance variation of the UV lamp 25, while the second part of $(\alpha_{1t} - \alpha_{10})x$ is relevant to the performance variation of the filter in the purifying chamber 10. Therefore, $\log I_{10} - \log I_{1t}$ is a good indicator of the overall performance of the water purifier 100. Generally speaking, emission intensity is much more important than water quality to the detected UV light intensity, therefore, the performance variation of the UV lamp, if any, is much more important

to the difference between the reference first light intensity I_{10} and the updated first light intensity I_{1t} than the performance variation, if any, of the purifying chamber.

The following formula, e.g.

$$\log I_{10} - \log I_{1t} > A_1 \Delta \alpha_0 x \quad (8),$$

could be used to estimate the overall performance of the water purifier 100, wherein A_1 is a predetermined threshold. If formula (8) is not satisfied, then the overall performance of the water purifier 100 is OK, meaning that the water purifier 100 can still operate in normal working conditions. Otherwise, if formula (8) is satisfied, then the performance of the filter in the purifying chamber 10 or the performance of the UV lamp 25 decreases too much, meaning that at least one of the filter and the UV lamp needs to be replaced by a standby element. When formula (8) is satisfied, the water purifier 100 turns to an estimation phase.

Further estimation is carried out with the help of the up-to-date second light intensity. When formula (8) is satisfied and the up-to-date first light intensity I_{1t} is recorded, the switch unit 30 is turned to the second position, so that the water in the reactor 20 is replaced by water coming from the water source 80 and bypassing the purifying chamber 10, so that the up-to-date second light intensity I_{2t} can be obtained. Therefore, the up-to-date QSD could be obtained as

$$\Delta \alpha_t = \frac{\log I_{1t} - \log I_{2t}}{x} \quad (9).$$

Many indicators could be used for further estimation of the performance of the filter.

For example, the up-to-date QSD could be used for further estimation of the performance of the filter. To be specific, the following formula, e.g.

$$\Delta \alpha_t < A_2 \quad (10),$$

could be used, wherein A_2 is a predetermined threshold of QSD. If formula (10) is satisfied, it means that the performance of the filter in the purifying chamber 10 decreases too much, so that the filter needs to be replaced by a standby filter.

According to another example, an approximate integral of the curve in Fig.2 could be used for further estimation of the performance of the filter. To be specific, the following formula, e.g.

$$\frac{1}{2}(\Delta\alpha_t + \Delta\alpha_0)(V_t - V_0) > A_3 \quad (11),$$

could be used, wherein V_0 is the total volume of water purified by the filter when the reference first light intensity I_{10} is obtained, V_t is the total volume of water purified by the filter when the up-to-date first light intensity I_{1t} is obtained, A_3 is a predetermined threshold of filter performance, $\frac{1}{2}(\Delta\alpha_t + \Delta\alpha_0)(V_t - V_0)$ is the approximate integral of the curve in Fig.2. If formula (11) is satisfied, then the performance of the filter in the purifying chamber 10 decreases too much, meaning that the filter needs to be replaced by a standby filter. In this case, the water purifier 100 further comprises a sensor (not shown), such as a flowmeter, adapted for measuring the total volume of water purified by the filter (i.e. the purifying chamber 10).

The water purifier 100 may further comprise a display unit (not shown). When the processor 50 finds that the filter in the purifying chamber 10 needs to be replaced, the display unit is controlled so as to show a corresponding indicator to warn the user.

Further estimation of the performance of the UV lamp is also possible by means of the up-to-date second light intensity. Advantageously, the processor 50 is further adapted for determining the performance of the UV lamp 25 on the basis of the reference second light intensity I_{20} and the up-to-date second light intensity I_{2t} . To be specific, the following formula, e.g.

$$\log I_{20} - \log I_{2t} > A_4 \quad (12),$$

could be used for this purpose, wherein A_4 is a predetermined threshold of UV lamp performance. If formula (12) is satisfied, then the performance of the UV lamp 25 decreases too much, meaning that the UV lamp needs to be replaced by a standby UV lamp.

When the processor 50 finds that the UV lamp 25 needs to be replaced, the display unit is controlled so as to show a corresponding indicator to warn the user.

It needs to be indicated that the filter in the purifying chamber 10 and the standby filter(s) are preferably of the same type or specifications, and the UV lamp 25 and the standby UV lamp(s) are preferably also of the same type or specifications. Besides, the above thresholds, i.e. A_1 , A_2 , A_3 and A_4 , should be measured in advance or predetermined for the combination of this type of filter and this type of UV lamp. Otherwise, a plurality of sets of thresholds should be measured in advance or predetermined, each set of threshold corresponding to a combination of one possible type of filter and one possible type of UV lamp.

In another embodiment, the purifying chamber 10 of the water purifier 100 comprises an oxidation reactor. In this case, a preferred monitoring process, which is similar to that mentioned above, is given hereinbelow.

First, there is an initialization phase, wherein a first light intensity I_{10} and a second light intensity I_{20} are obtained within a very short period of time since a new filter in the purifying chamber 10 is put into use, and these intensities are recorded for reference. And the reference QSD ($\Delta\alpha_0$) can be obtained.

And then the water purifier 100 operates in a normal working phase as mentioned above. The first light intensity will be obtained in accordance with a predetermined schedule, for example once every preset period of time or once every preset water volume purified by the purifying chamber 10. The up-to-date first light intensity is represented as I_{1t} . As mentioned above, $\log I_{10} - \log I_{1t}$ could be calculated as an indication of the overall performance of the water purifier 100.

The following formula, e.g.

$$\log I_{10} - \log I_{1t} > A_5 \Delta\alpha_0 x \quad (13),$$

could be used to estimate the overall performance of the water purifier 100, wherein A_5 is a predetermined threshold. If formula (13) is not satisfied, then the overall performance of the water purifier 100 is OK, meaning that the water purifier 100 can still operate in normal

working conditions. Otherwise, if formula (13) is satisfied, then the performance of the oxidation reactor in the purifying chamber 10 or the performance of the UV lamp 25 decreases too much, meaning that the oxidation reactor needs to be adjusted and/or the UV lamp needs to be replaced. When formula (13) is satisfied, the water purifier 100 turns to an estimation phase.

Further estimation is performed with the help of the up-to-date second light intensity. When formula (13) is satisfied and the up-to-date first light intensity I_{1t} is recorded, the switch unit 30 is turned to the second position, i.e. the up-to-date second light intensity I_{2t} can be obtained. Therefore, the up-to-date QSD ($\Delta\alpha_t$) can be obtained.

For example, the up-to-date QSD could be used for further estimation of the performance of the filter. To be specific, the following formula, e.g.

$$\Delta\alpha_t < A_6 \quad (14),$$

could be used, wherein A_6 is a predetermined QSD threshold. If formula (14) is satisfied, then the performance of the oxidation reactor in the purifying chamber 10 decreases too much, meaning that the oxidation reactor needs to be adjusted, for example replenishment of oxidant.

Further estimation of the performance of the UV lamp is also possible by means of the up-to-date second light intensity. Advantageously, the processor 50 is further adapted for determining the performance of the UV lamp 25 on the basis of the reference second light intensity I_{20} and the up-to-date second light intensity I_{2t} . To be specific, the following formula, e.g.

$$\log I_{20} - \log I_{2t} > A_7 \quad (15),$$

could be used for this purpose, wherein A_7 is a predetermined threshold of the UV lamp performance. If formula (15) is satisfied, then the performance of the UV lamp 25 decreases too much, meaning that the UV lamp needs to be replaced by a standby UV lamp.

It needs to be indicated that the UV lamp 25 and the standby UV lamp(s) are preferably of the same type or specifications. It is intelligible that the thresholds A_5 , A_6 and A_7 may be

different from A_1 , A_2 and A_4 , because of the difference between a filter and an oxidation reactor.

Fig.3 depicts a water purifier 100a according to the invention. The water purifier 100a has a structure similar to that of the water purifier 100, except for the difference between the switch unit 30a and the switch unit 30. The switch unit 30a comprises a shunt valve with one inlet connected to the water source 80a and two outlets connected to the purifying chamber 10a and the reactor 20a, respectively. When the water purifier 100a is in operation, water flows through the water purifier 100 along the paths generally indicated by the arrows. When the switch unit 30a is in the first position, the upper outlet (as shown in Fig.3) is open and the lower outlet (as shown in Fig.3) is closed, so that water coming from the water source 80a will flow through the purifying chamber 10a and fill the reactor 20a. When the switch unit 30a is in the second position, the upper outlet is closed and the lower outlet is open, so that water coming from the water source 80a will bypass the purifying chamber 10a and fill the reactor 20a.

The water purifier 100a further comprises a filter 16a for filtering the water coming from the water source 80a before it enters the reactor 20a, wherein, if the switch unit 30a is in the second position, water flows through the filter 16a before it fills the reactor 20a. This filter 16a is only used for calibration. That is to say, water from filter 16a is deemed to be water of good quality and is used as reference to determine the quality of other water. With the implementation of the filter 16a, when the second light intensity is obtained, water bypassing the purifying chamber 10a and filling the reactor 20a has stable quality.

In the case that the purifying chamber 10a comprises a carbon filter, a similar preferable monitoring process as mentioned above could be implemented by the processor 50a. It is intelligible that the thresholds may be different from A_1 , A_2 , A_3 and A_4 , because of the introduction of the filter 16a.

In the case that the purifying chamber 10a comprises an oxidation reactor, a similar preferable monitoring process as mentioned above could also be implemented. It is intelligible that the

thresholds may be different from A_5 , A_6 and A_7 , because of the introduction of the filter 16a.

Fig.4 depicts a method according to the invention of determining the performance of a purifying chamber in a system, said system also comprising a reactor with a UV lamp for disinfecting water flowing through said reactor, said purifying chamber being in fluid communication with said reactor. Said method comprises the steps of:

- obtaining (S41) a first light intensity of the light beam emitted by said UV lamp after said light beam has passed through water, which comes from a water source and passes through said purifying chamber, in said reactor;
- obtaining (S42) a second light intensity of the light beam emitted by said UV lamp after said light beam has passed through water, which comes from said water source without passing through said purifying chamber, in said reactor; and
- determining (S43) the performance of said purifying chamber on the basis of said first light intensity and said second light intensity.

This method corresponds to a monitoring process carried out by the processor 50 in a water purifier according to Fig.1, or it corresponds to a monitoring process carried out by the processor 50a in a water purifier according to Fig.3.

In an embodiment of the method, said purifying chamber comprises a carbon filter or an oxidation reactor.

In an embodiment of the method, water from said water source is tap water.

In an embodiment of the method, said method further comprises a step preceding step S43: - obtaining the volume of water purified by said purifying chamber. This step corresponds to an operation carried out by the flowmeter as mentioned above.

Said step S43 further comprises: - determining the performance of said purifying chamber on the basis of said first light intensity, said second light intensity and said volume. This step corresponds to the further estimation of the performance of the filter by using an approximate integral of the curve in Fig.2 as an indicator, as mentioned above.

In an embodiment of the method, said system further comprises a filter adapted for filtering the water from said water source before it enters said reactor, wherein, in step S42, water in said reactor has flowed through said filter before entering said reactor. This filter corresponds to filter 16a, as mentioned above.

Fig.5 depicts a method according to the invention of detecting the performance of a UV lamp in a water purifying system, said UV lamp being adapted for disinfecting water flowing through a reactor. Said method comprises the steps of:

- obtaining (S51) a reference light intensity of a light beam emitted by said UV lamp after said light beam has passed through water, which comes from a water source, in said reactor;
- obtaining (S52) an updated light intensity of the light beam emitted by said UV lamp after said light beam has passed through water, which comes from said water source, in said reactor;
- determining (S53) the performance of said UV lamp on the basis of said reference light intensity and said updated light intensity.

Step S51 corresponds to the step of obtaining a reference second light intensity during the initialization phase as mentioned above, which is carried out by the processor. Step S52 corresponds to the step of obtaining the up-to-date second light intensity during the estimation phase as mentioned above, which is carried out by the processor. Step S53 corresponds to the further estimation of the performance of the UV lamp, which is carried out by the processor.

In an embodiment of the method, water from said water source is tap water.

In an embodiment of the method, in said step S51 and said step S52, water in said reactor is purified by a filter before it enters said reactor. This step corresponds to the action carried out by the filter 16a, as mentioned above.

In an embodiment of the method, step S51 is executed the first time to flush said UV lamp. This feature corresponds to the step of obtaining a reference second light intensity during the initialization phase as mentioned above, which is carried out by the processor.

In an embodiment of the method, said method further comprises the step preceding step S52:

- determining the performance of said water purifying system;
- if said performance of said water purifying system does not meet a predetermined criterion, step S52 and step S53 are executed.

This step corresponds to the estimation of the overall performance of the water purifier as mentioned above, which is carried out by the processor.

Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. A single unit may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. Any reference signs in the claims should not be construed as limiting the scope thereof.

CLAIMS

1. A water purifier comprising:
 - a purifying chamber for purifying water coming from a water source;
 - a reactor comprising a UV lamp for disinfecting water flowing through said reactor;
 - a switch unit adapted to take a first position to allow water coming from said water source to flow through said purifying chamber and to fill said reactor; and adapted to take a second position to allow water coming from said water source to bypass said purifying chamber and fill said reactor,
 - a sensor configured to obtain a light intensity of the light beam emitted by said UV lamp after said light beam has passed through the water in said reactor; and
 - a processor adapted to:
 - obtain a first light intensity by said sensor, when said switch unit is in said first position;
 - obtain a second light intensity by said sensor, when said switch unit is in said second position; and
 - determine the performance of said purifying chamber on the basis of said first light intensity and said second light intensity.
2. A water purifier as claimed in claim 1, wherein said purifying chamber comprises a carbon filter or an oxidation reactor.
3. A water purifier as claimed in claim 1, further comprising a filter for filtering water coming from said water source before it enters said reactor, wherein, if said switch unit is in said second position, water flows through said filter before filling said reactor.
4. A water purifier as claimed in claim 1, wherein said processor is further adapted for determining the performance of said UV lamp.
5. A method of determining the performance of a purifying chamber in a system, said system also comprising a reactor with a UV lamp for disinfecting water flowing through said reactor, said purifying chamber being in fluid communication with said reactor, said method comprising the steps of:

a. obtaining a first light intensity of the light beam emitted by said UV lamp after said light beam has passed through water, which comes from a water source and passes through said purifying chamber, in said reactor;

b. obtaining a second light intensity of the light beam emitted by said UV lamp after said light beam has passed through water, which comes from said water source without passing through said purifying chamber, in said reactor; and

c. determining the performance of said purifying chamber on the basis of said first light intensity and said second light intensity.

6. A method as claimed in claim 5, wherein said purifying chamber comprises a carbon filter or an oxidation reactor.

7. A method as claimed in claim 5, wherein water from said water source is tap water.

8. A method as claimed in claim 5, wherein said method further comprises a step preceding step c:

- obtaining the volume of water purified by said purifying chamber;

- step c further comprising:

- determining the performance of said purifying chamber on the basis of said first light intensity, said second light intensity and said volume.

9. A method as claimed in claim 5, said system further comprising a filter adapted for filtering water from said water source before it enters said reactor, wherein, in step b, water in said reactor flows through said filter before entering said reactor.

10. A method of detecting the performance of a UV lamp in a water purifying system, which UV lamp is adapted for disinfecting water flowing through a reactor, said method comprising the steps of:

- A. obtaining a reference light intensity of a light beam emitted by said UV lamp after said light beam has passed through water, which comes from a water source, in said reactor;

- B. obtaining an updated light intensity of a light beam emitted by said UV lamp after said light beam has passed through water, which comes from said water source, in said reactor;

C. determining the performance of said UV lamp on the basis of said reference light intensity and said updated light intensity.

11. A method as claimed in claim 10, wherein, water from said water source is tap water.

12. A method as claimed in claim 10, wherein, in said step A and said step B, water in said reactor is purified by a filter before it enters said reactor.

13. A method as claimed in claim 10, wherein step A is executed the first time to flush said UV lamp.

14. A method as claimed in claim 10, further comprising the step preceding step B, said preceding step including:

- determining the performance of said water purifying system;
- if said performance of said water purifying system does not meet a predetermined criterion, executing step B and step C.

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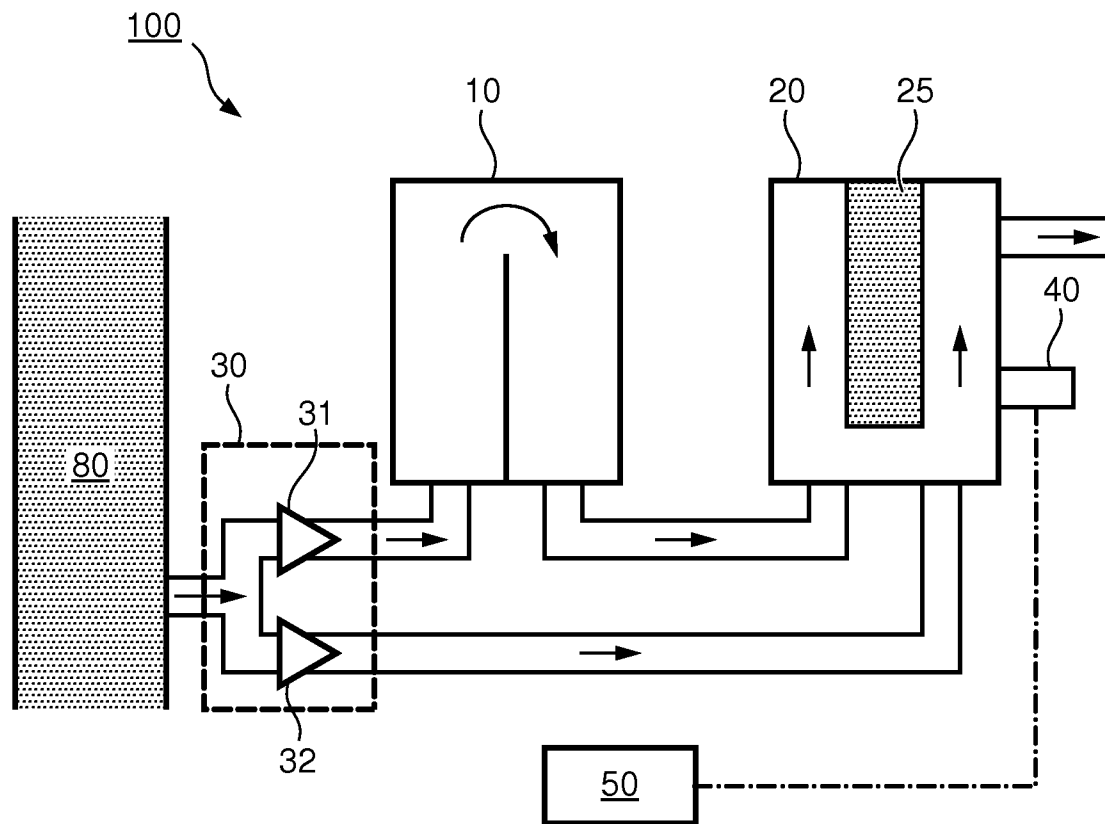


FIG. 1

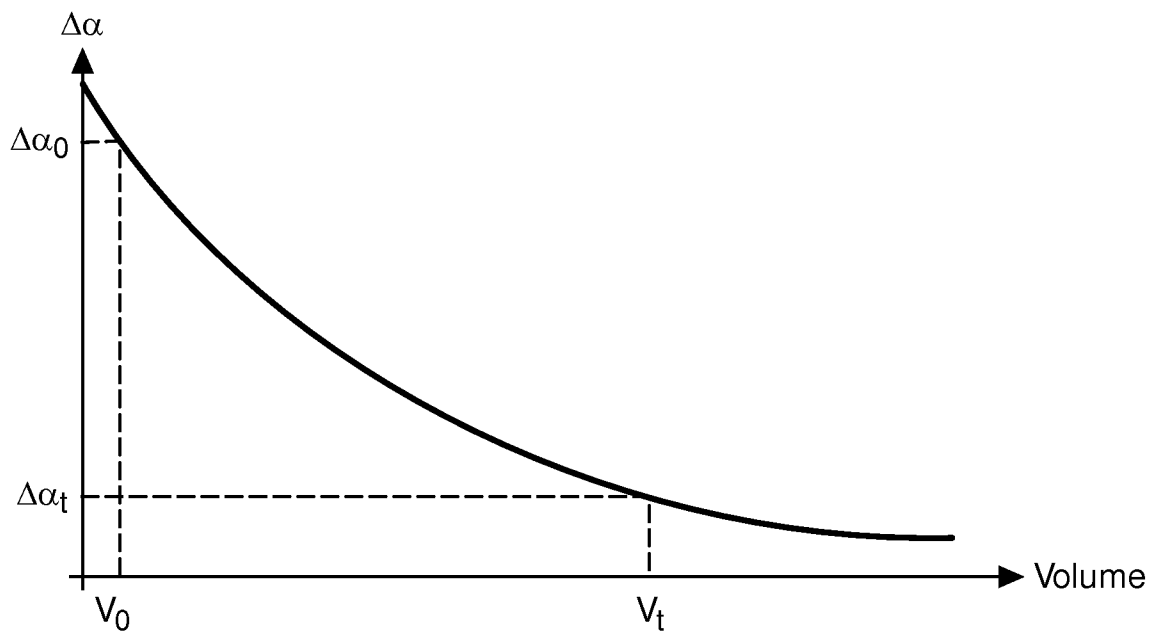


FIG. 2

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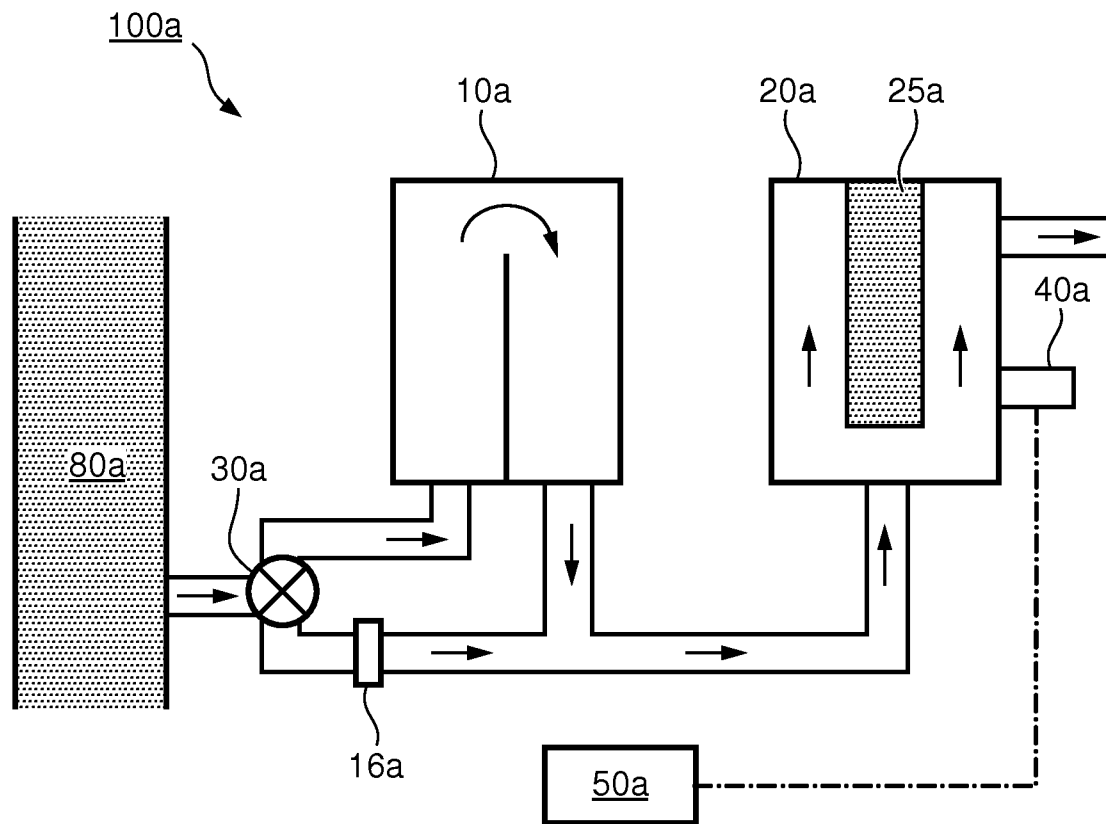


FIG. 3

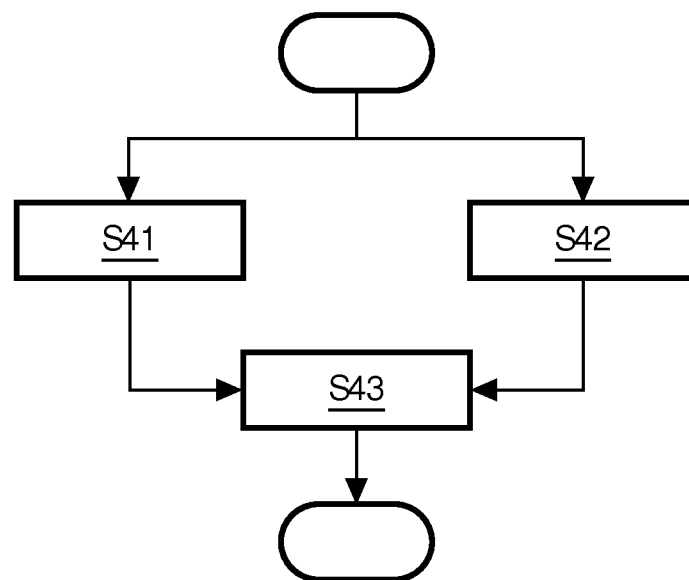


FIG. 4

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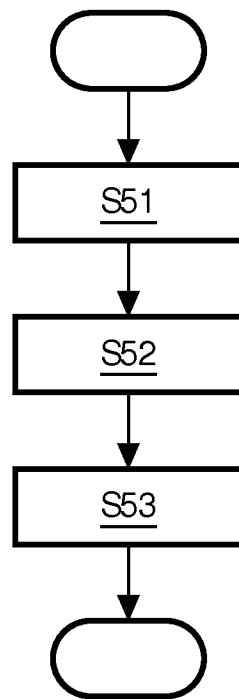


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2012/050729

A. CLASSIFICATION OF SUBJECT MATTER
 INV. C02F1/32 G01J1/42
 ADD.

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)
 C02F G01J

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/190826 A1 (MINER JEFFERY G [US] ET AL MINER JEFFREY G [US] ET AL) 14 August 2008 (2008-08-14) paragraphs [0044] - [0045], [0063] - [0065]; figure 2 -----	1-14
X	WO 2010/062032 A2 (PANASIA CO LTD) 3 June 2010 (2010-06-03) paragraphs [0095] - [0098]; figure 1 -----	1-14
X	WO 2007/031041 A1 (SCHNEIDER STEPHAN [DE]; HEYER UWE [DE]) 22 March 2007 (2007-03-22) page 5 - page 8; figure 1 -----	1-14



Further documents are listed in the continuation of Box C.



See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

29 May 2012

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2012/050729

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