Title of the Invention: A CLEANING AND STERILIZING AGENT AND SYSTEM AND METHOD OF PRODUCING THE SAME

Field of the Invention

The invention relates to a safe, non-toxic and environmentally friendly cleaning and sterilizing agent consisting of alkaline electrolyzed/ionized water with a PH value greater than 12, and a system and method for producing or generating the cleaning and sterilizing agent or the strong alkaline ionized water.

Background

Various cleaning products are available on the market, for example, general household cleaning solutions for the kitchen, cooking utensils, and bathrooms, etc., and cleaning products for industrial and commercial facilities. Also, a lot of disinfectants and sanitizers have been designed to kill bacteria and germs on skin and surfaces of objects, e.g. fruit and vegetable wash, and hand sanitizers, etc. In general, each type or brand of existing products in the market will address only one specific application. Moreover, most of the products may pollute environment and cause potential hazardous to human health, especially children, due to high chemical content thereof.

Further, due to the COVID-19 pandemic in the whole world recently, the need and use of the sterilization products, e.g. hand sanitizers and disinfectants, are significantly increased. However, some of the products are not effective against the COVID-19 viruses, while the effective ones may not be suitable for

frequent use and for sensitive skin due to the alcohol and/or other active chemical ingredients therein.

It is therefore desirable to provide a safe, non-toxic, environmentally friendly and effective multi-purpose cleaning and sterilizing agent, as well as the method and system for producing the same.

Summary of the Invention

Embodiments of the invention provide a cleaning and sterilizing agent which comprises only water and less than 1% of food-grade ingredient. This cleaning and sterilizing agent is effective for both general cleaning purpose and sterilization purpose, e.g. killing bacteria and human viruses. Embodiments of the invention also provide a system and method for generating/producing the cleaning and sterilizing agent.

According to a first aspect of the embodiments of the invention, a cleaning and sterilizing agent is provided. The agent consists of greater than 99% of water and less than 1% of potassium hydroxide (KOH), and having a PH value greater than 12. Preferably, the agent has a PH value in a range of 12.7-13.5.

According to a second aspect of the embodiments of the invention, a system for producing a cleaning and sterilizing agent according to the first aspect is provided. The system comprises: at least one electrolytic cell, each electrolytic cell including an anodic chamber with a first inlet and a first outlet and an cathodic

chamber with a second inlet and a second outlet, a first tank, a second tank and a controller, wherein

the first tank is configured to hold electrolyte solution for electrolysis process and be fluid communicable with the anodic chamber of each of the at least one electrolytic cell through the first inlet and the first outlet of the anodic chamber, wherein the electrolyte solution is potassium carbonate k_2CO_3 solution;

the second tank is configured to hold water to be ionized and be fluid communicable with the cathodic chamber of the each of the at least one electrolytic cell through the second inlet and the second outlet of the cathodic chamber; and

the controller is configured to control, based on a first predetermined PH value and a PH value measured in the second tank, or a predetermined time period, a first fluid circulation process conducted between the anodic chamber of the each of the at least one electrolytic cell and the first tank; and a second fluid circulation process conducted between the cathodic chamber of the each of the at least one electrolytic cell and the second tank to produce alkaline ionized water, i.e. the cleaning and sterilizing agent proposed in embodiments of the invention.

According to a third aspect of the embodiments of the invention, a method for producing a cleaning and sterilizing agent according to the first aspect is provided. The method comprises:

providing electrolyte solution in a first tank which is fluid communicable with an anodic chamber of each of at least one electrolytic cell through a first inlet and a first outlet of the anodic chamber, wherein the electrolyte solution is potassium K2CO3 solution;

providing water to be ionized in a second tank which is fluid communicable with the cathodic chamber of the each of the at least one electrolytic cell through a second inlet and a second outlet of the cathodic chamber; and

controlling, by a controller, based on a first predetermined PH value and a PH value measured in the second tank, or a predetermined time period, a first fluid circulation process conducted between the anodic chamber of the each of the at least one electrolytic cell and the first ~~rank~~tank; and a second fluid circulation process conducted between the cathodic chamber of the each of the at least one electrolytic cell and the second tank to produce alkaline ionized water.

Brief Description of the Drawing

The invention will be described in detail with reference to the accompanying drawings, in which:

[Fig. 1] is a schematic diagram showing a system for producing a cleaning and sterilizing agent or alkaline ionized water with a predetermined PH value greater than 12 according to a first embodiment of the invention;

[Fig .2] is a schematic diagram showing an electrolytic cell according to some embodiments of the invention;

[Fig. 3] is a schematic diagram showing a system for producing the cleaning and sterilizing agent according to a second embodiment of the invention;

[Fig. 4] is a schematic diagram showing a group of electrolytic cells used in a system for producing the cleaning and sterilizing agent according to some embodiments of the invention;

[Fig. 5] is a flowchart illustrating a method for producing a cleaning and sterilizing agent according to one embodiment of the invention.

Detailed Description of Embodiments of the Invention

In the following description, numerous specific details are set forth in order to provide a thorough understanding of various illustrative embodiments of the invention. It will be understood, however, to one skilled in the art, that embodiments of the invention may be practiced without some or all of these specific details. It is understood that the terminology used herein is for the purpose of describing particular embodiments only and is not intended to limit the scope of the invention.

Embodiments described in the context of one of the systems or methods are analogously valid for the other systems or methods. Similarly, embodiments described in the context of a method are analogously valid for a system, and vice versa.

Features that are described in the context of an embodiment may correspondingly be applicable to the same or similar features in the other

embodiments. Features that are described in the context of an embodiment may correspondingly be applicable to the other embodiments, even if not explicitly described in these other embodiments. Furthermore, additions and/or combinations and/or alternatives as described for a feature in the context of an embodiment may correspondingly be applicable to the same or similar feature in the other embodiments.

As used herein, the articles “a”, “an” and “the” as used with regard to a feature or element include a reference to one or more of the features or elements.

As used herein, the term “configured to” is interchangeable with “operative to” or “adapted to”.

As used herein, the term “coupled to” refers to connecting to an element with or without a coupling means.

Embodiments of the invention provide a cleaning and sterilizing agent consisting of greater than 99% of water and less than 1% of food grade active ingredient potassium hydroxide (KOH), and having a PH value greater than 12.

In some embodiments of the invention, the cleaning and sterilizing agent may be produced through an electrolysis/ionization process. It should be noted that the agent may also be generated by other methods in other embodiments.

In some embodiments of the invention, the agent may have a PH value in a range of 12.7 to 13.5.

In some embodiments of the invention, the agent may comprise 0.8% of potassium hydroxide KOH.

As the agent only includes pure water and less than 1% of safe food-grade active ingredient KOH, this agent is a green product that is very safe, non-toxic and environmentally friendly. Further, the cleaning and sterilizing agent proposed in embodiments of the invention is an effective multi-purpose solution which may be used for the following purposes:

1. General cleaning solution

As the agent consists of strong alkaline ionized water having a PH value greater than 12, even up to 13.5, it can be used as an effective cleaning solution against stubborn oil and dirt stains. For example, the agent can be used as a substitute of general kitchen, bathroom, and/or toilet cleaning solutions. Experiments have shown that the agent proposed in embodiments of this invention is an effective substitute of general kitchen, bathroom, and/or toilet cleaning solutions.

2. Sterilization solution

Tests have been conducted to assess the sterilization efficacy of the agent proposed by embodiments of the invention. The test results have indicated that after applying the agent on a surface for 15 seconds, more than 99.99996% or 6.38 log10 of bacteria on the surface will be killed.

3. Disinfection solution

Tests have also been conducted to assess the disinfection efficacy of the agent proposed in embodiments of the invention. The test results have indicated that after applying the agent on a surface for 15 seconds, no less than 99.90 or 3.00 Log10 of viruses on the surface will be killed. It should be noted that test results have shown that the agent proposed by embodiments of the invention is effective against human coronavirus, e.g. COVID-19 viruses.

4. Food Processing

Experiments have also shown that the agent proposed in embodiments of the invention can be used as fruit/vegetable wash to effectively remove the pesticides and other contaminants on the surface of the fruits and vegetables.

Also, the agent may be used as meat sanitizer for meat processing plant or home use to get rid of bacteria / viruses found on contaminated uncooked meat, e.g. fish and other seafood.

5. Hand sanitizer

Since the test results have proved that the agent is an effective solution for killing bacteria and viruses, clearly, the agent can be used as effective hand sanitizer.

6. Larvicide and insecticide against mosquitoes

As the agent consists of strong alkaline water having a PH value greater than 12, it may also be used as larvicide and insecticide against mosquitoes.

In view of the above, the agent proposed by the embodiments of the invention may be used for general cleaning and sterilization and have higher cleaning potency and proven efficacy against human coronavirus and bacteria due to its higher PH value.

Embodiments of the invention also provide an electrolysis/ionization system for producing the cleaning and sterilizing agent or the strong alkaline ionized water.

[Fig. 1] is a schematic diagram showing a system 100 for producing a cleaning and sterilizing agent or alkaline ionized water with a predetermined PH value greater than 12 according to a first embodiment of the invention. Referring to [Fig. 1], the system 100 includes an electrolytic cell 101, an electrolyte tank/first tank 102, an intermediate/second tank 103 and a controller 104.

The electrolytic cell 101 includes an anodic chamber 101A with a first inlet 101A-1 and a first outlet 101A-2 and a cathodic chamber 101B with a second inlet 101B-1 and a second outlet 101B-2. The electrolytic cell 101 also includes a cation semi-permeable membrane 101C between the ~~android~~ anodic chamber 101A and the cathodic chamber 101B to allow ion exchange between the two chambers.

When the electrolytic cell 101 is used in an electrolysis process, an electrolyte solution, e.g. potassium carbonate K_2CO_3, is provided in the anodic chamber 101A, and water to be ionized is provided in the cathodic chamber 101B. When a voltage is applied across the anode 101D and cathode 101E of the electrolytic cell 101, a current is generated passing through the electrolytic cell 101 via the semi-permeable membrane 101C. The electrolyte solution is electrolyzed

in the cathodic chamber 101B to form hydrogen gas and hydroxide ions. The potassium ions are attached to the cathode 101E and react with the hydroxide ions to create a caustic potassium hydroxide (KOH) solution. With the increase of hydroxide ions in the cathodic chamber 101B, the PH value in the cathodic chamber 101B will increase.

The chemical equations below show the electrolysis process in the electrolytic cell 101.

Anode:	Cathode:
$H_2O \rightarrow ½\ O_2 + 2H^+$	$H_2O \rightarrow H^+ + OH^-$
$CO_3^{2-} + H^+ \rightarrow HCO_3^-$	$H^+ + e^- \rightarrow ½\ H_2$
$HCO_3^- + H^+ \rightarrow H_2CO_3 \rightarrow H_2O + CO_2$	$K^+ + OH^- \rightarrow KOH$

The first or electrolyte tank 102 is configured to hold electrolyte solution for the electrolysis process and be fluid communicable with the anodic chamber 101A through the first inlet 101A-1 and the first outlet 101A-2 thereon. In this embodiment, the electrolyte solution may be potassium carbonate k_2CO_3 solution. As shown in [Fig. 1], the first inlet 101A-1 and the first outlet 101A-2 are disposed on the bottom surface and the top surface of the anodic chamber 101A respectively, however, it is to be appreciated by a person skilled in the art that this is only for illustration purpose, not to limit the scope of the invention. In other embodiments, the first inlet 101A-1 and the first outlet 101A-2 may be disposed on other parts of the anodic chamber 101A.

The second/intermediate tank 103 is configured to hold water to be ionized and be fluid communicable with the cathodic chamber 101B through the second inlet 101B-1 and the second outlet 101B-2. As shown in [Fig. 1], the second inlet 101B-1 and the second outlet 101B-2 are disposed on the bottom surface and the top surface of the cathodic chamber 101B respectively, however, it is to be appreciated by a person skilled in the art that this is only for illustration purpose, not to limit the scope of the invention. In other embodiments, the second inlet 101B-1 and the second outlet 101B-2 may be disposed on other parts of the cathodic chamber 101B.

In this embodiment, before a voltage is applied to the anode 101D and cathode 101E of the electrolytic cell 101, the electrolyte solution may be provided in the anodic chamber 101A from the first tank/electrolyte tank 102 through the first inlet 101A-1 of the anodic chamber 101A and water to be ionized may be provided in the cathodic chamber 101B from the second tank 103 through the second inlet 101B-1 of the cathodic chamber 101B. In some embodiments of the invention, the transfer of the electrolyte solution may be stopped until the first tank 102 is full or the solution in the first tank 102 reaches a predetermined level; and the transfer of the water to be ionized may be stopped until the second tank 103 is full or the water in the second tank reaches a predetermined level.

The controller 104 is configured to control, based on a first predetermined PH value and a PH value measured in the second tank 103, or a predetermined time period, a first fluid circulation process conducted between the anodic chamber 101A and the first tank 102 through the first inlet 101A-1 and the first

outlet 101A-2; and a second fluid circulation process conducted between the cathodic chamber 101B and the second tank 103 through the second inlet 101B-1 and the second outlet 101B-2 to produce alkaline ionized water, i.e. the cleaning and sterilizing agent. The first predetermined PH value may be in a range of 12.7 to 13.5.

The controller 104 may include a printed circuit board (PCB) with microcontroller or a processor in a computer system to automate the various tasks in the electrolysis process. The computer system may be a laptop, a desktop, a tablet, or any other types of computer systems.

In this embodiment, the controller 104 may be configured to stop the first and the second fluid circulation processes when the PH value measured in the second tank 103 is not less than the first predetermined PH value. The PH value in the second tank 103 may be measured by a first PH meter 105 as shown in [Fig. 1].

Alternatively, the controller 104 may be configured to stop the first and the second fluid circulation processes when the circulation processes have been conducted for a predetermined time period. It should be noted that in some embodiments of the invention, the controller 104 may be configured to control the first and the second fluid circulation processes based on the predetermined time period when the controller 104 fails to obtain the PH value in the second tank 103 and control the circulation processes based on the first predetermined PH value.

To clearly show the components of the electrolytic cell in some embodiments of the invention, [Fig .2] is a schematic diagram showing an electrolytic cell 201 according to some embodiments of the invention. As shown in [Fig. 2], the electrolytic cell 201 includes an anodic chamber 201A with a first inlet 201A-1 and a first outlet 201A-2, a cathodic chamber 201B with a second inlet 201B-1 and a second outlet 201B-2, and a cation semi permeable membrane 201C between the ~~android~~ anodic chamber 201A and the cathodic chamber 201B to allow ion exchange between the two chambers. The electrolytic cell 201 also includes an anode 201D disposed in the anodic chamber 201A and a cathode 201E disposed in the cathodic chamber 201B. Each of the first inlet 201A-1 and the first outlet 201A-2 is configured to be coupled to a fluid transfer device (not shown in [FIG. 2]) to build up a passage for conducting the first fluid circulation process between the first tank and the anodic chamber 201A. Similarly, each of the second inlet 201B-1 and the second outlet 201B-2 is configured to be coupled to a fluid transfer device (not shown in [FIG. 2]) to build up a passage for conducting the second fluid circulation process between the second tank and the cathodic chamber 201B. In some embodiments, the fluid transfer device may include a pipeline, at least one valve and a pump.

[Fig. 3] is a schematic diagram showing a system 300 for producing the cleaning and sterilizing agent, i.e. alkaline ionized water with a PH value greater than 12, according to a second embodiment of the invention. Referring to [Fig. 3], the system 300 includes an electrolytic cell 301, an electrolyte/first tank 302, an intermediate/second tank 303, and a controller 304. As these components are

similar to the corresponding components in the embodiment shown in [Fig. 1], the features of these components will not be repeated here.

In this embodiment, the system 300 may further include a first PH meter 305 configured to measure a PH value in the second tank 303, wherein the controller 304 is further configured to stop the first and the second fluid circulation processes when the PH value measured by the first PH meter 305 is not less than the first predetermined PH value. The first PH meter 305 may be installed in the second tank 303 and wirelessly communicable with the controller 304. In some examples, the first PH meter 305 may communicate with the controller 304 in a wire manner.

In this embodiment, the controller 304 may be further configured to control the first and the second fluid circulation processes through controlling fluid transfer devices arranged for the first and the second fluid circulation processes, wherein a fluid transfer device may include a pipeline, at least one valve and a pump. As shown in [Fig. 3], in this embodiment, the fluid transfer device arranged for the first fluid circulation process may include pipeline, pump 3, and valve 2; the fluid transfer device arranged for the second fluid circulation process may include pipeline, pump4 and valves 4 and 5.

In this embodiment, the system 300 may further include a second PH meter 306 configured to measure a PH value in the first tank 302, and a third/solvent tank 307 which is configured to hold concentrated electrolyte solution, wherein the controller 304 may be further configured to control discharge of the concentrated electrolyte solution from the third tank 307 to the first tank 302 based

on the PH value measured by the second PH meter 306 and a second predetermined PH value. For example, the controller 304 may control to discharge the concentrated electrolyte solution into the first tank 302 when the PH value measured by the second PH meter 306 is less than the second predetermined PH value. In one example, the second predetermined value may be 9.

Alternatively, the controller 304 may be configured to control the discharge process based on a predetermined time interval instead of the PH values. The predetermined time interval may be determined based on experience and experiments. For example, the controller 304 may be configured to allow the discharge of the concentrated electrolyte solution from the third tank 307 after a fixed time interval.

In this embodiment, the controller 304 may be further configured to control a discharge amount and/or discharge time period of the concentrated electrolyte solution from the third tank 307 based on the PH value measured by the second PH meter 306 and the second predetermined PH value.

In this embodiment, the controller 304 may be further configured to control the discharge of the concentrated electrolyte solution from the third tank 307 to the first tank 302 based on the PH value measured by the second PH meter 306 and a second predetermined PH value after the first and the second fluid circulation processes are stopped. In other words, the electrolyte solution in the first tank 302 may only be renewed after a production cycle of the agent is completed. It should be noted that in some embodiments, a certain amount of

depleted electrolyte solution in the first tank 302 may need to be discharged either before or simultaneously with adding the additional concentrated electrolyte solution if the first tank 302 is full of depleted electrolyte solution.

In this embodiment, the controller 304 may be further configured to control the discharge of the concentrated electrolyte solution through controlling a fluid transfer device arranged for the discharge process. As shown in [Fig. 3], the fluid transfer device may include a pipeline, a valve 9 and a pump 2.

In this embodiment, the concentrated electrolyte solution in the third tank 307 may be generated/produced by adding electrolyte power into water. To sufficiently dissolve the electrolyte power in water, the system 300 may further include a stirrer 308 disposed in the third tank 307 to produce the concentrated electrolyte aqueous solution. The controller 304 may be further configured to control a stirring speed and/or time of the stirrer 308 to sufficiently dissolve the electrolyte power in water.

In this embodiment, the water to be ionized in the second tank 302 may be Reverse Osmosis (RO) water or filtered water to ensure good quality control and production consistency. If there are contaminants in the water to be ionized, they will be subjected to electrolysis as well. This will further contaminate the produced alkaline ionized water and may affect its efficacy. Accordingly, the system 300 may further include a RO water tank 309 configured to hold RO water, and a first fluid transfer device arranged for transferring the RO water in the RO water tank 309

to the second tank 303. The first fluid transfer device may include a pipeline, valve 3, valve 5 and pump 4 as shown in [Fig. 3].

As shown in [Fig. 3], the RO water may be generated/produced via a 5-stage filtering process 310 namely the PP filter, activated carbon filter (ACF), softener, Ultra filter (UF) and RO membrane filter.

In this embodiment, the system 300 may further include a second fluid transfer device arranged for transferring the RO water in the RO water tank 309 to the first tank 302 to produce the electrolyte solution. The second fluid transfer device may include a pipeline, valve 1, valve 8 and pump 3 as shown in [Fig. 3].

As shown in [Fig. 3], the system 300 may further include a storage tank 311 configured to store the produced alkaline ionized water from the intermediate/second tank 303. In this embodiment, the produced alkaline ionized water may be transferred from the second tank 303 to the storage tank 311 though a fluid transfer device including a pipeline, valve 5, valve 6 and a pump 4. Once the produced alkaline ionized water is transferred from the second tank 303 to the storage tank 311, the system 300 will be ready to repeat the production process of the alkaline ionized water, i.e. start a next production cycle of the agent.

Referring to [Fig. 3], at least two water level sensors may be disposed in each of the following tanks to assess whether the tank is full or empty: the first tank 302, the second tank 303, the third tank 307, the RO water tank 309 and the storage tank 311. In each tank, one water level sensor may be installed at the bottom of the tank, another one may be installed near the top of the tank. A redundant water

level sensor may be provided to replace the main sensors in the event that the main sensors malfunction.

The system 300 may also include a current sensor 312 configured to detect a current value supplied by a power supply. The purpose of detecting the current value is to protect the power supply and the electrolytic cell 301 in the system 300. The power supply will be adjusted automatically based on the detected current value to maintain the current at a predetermined optimum value of the capacity of the electrolytic cell 301. The optimum value of the capacity of the electrolytic cell 301 depends on the rating of the electrolytic cell 301. If there are a plurality of electrolytic cells are used in the system, the optimum value may also depend on the number of electrolytic cells used in the system.

In this embodiment, the system 300 may further include a leakage detector which may be installed at a base of a chassis of the system 300 to signal leakage when liquid drops from any of the tanks in the system 300 are collected at the base.

In this embodiment, the system 300 may further include a user interface 313 configured to receive user inputs and transfer the same to the controller 304. The controller 304 may be further configured to receive user inputs through the user interface 313 and control the electrolysis process based on the user inputs. In some embodiments of the invention, the user inputs may include the first predetermined PH value, the second predetermined PH value and/or the

predetermined time period. In some embodiments, the user interface may be further configured to receive some or all of the following user inputs:

1. Operation mode: Manual / Automatic
2. Production mode: PH / Timer
3. Solvent Tank: internal /external
4. Automatic transfer to external storage tank: Yes / No
5. Solvent tank mixing time: (minutes)
6. Electrolyte renewal time: (minutes)
7. Produced alkaline ionized water PH level, i.e. the first predetermined PH value
8. Minimum pH level in the electrolyte tank, i.e. the second predetermined PH value
9. Electrolyte discharge time (seconds)

Both the system 100 shown in [Fig. 1] and the system 300 shown in [Fig. 3] only include one electrolytic cell 101/301. However, in some embodiments of the invention, to further improve the efficiency of producing strong alkaline ionized water, the system may include a plurality of electrolytic cells.

[Fig. 4] is a schematic diagram showing a group of electrolytic cells used in a system for producing the cleaning and sterilizing gent or strong alkaline ionized water according to some embodiments of the invention. In this invention, the system includes 6 electrolytic cells 401, each electrolytic cell has the same structure and functions as the electrolytic cell 101 or 301. Each of the electrolytic

cells 401 is further configure to be fluid communicable with the first tank through a common first inlet pipeline 41a and a common first outlet pipeline 41b; and to be fluid communicable with the second tank through a common second inlet pipeline 42a and a common second outlet pipeline 42b, wherein the common first inlet pipeline 41a is configured to be in fluid communication with the first inlet of each electrolytic cell; the common first outlet pipeline is configured to be in fluid communication with the first outlet of each electrolytic cell, wherein the common second inlet pipeline 42a is configured to be in fluid communication with the second inlet of each electrolytic cell; the common second outlet pipeline 42b is configured to be in fluid communication with the second outlet of each electrolytic cell. The group of electrolytic cells in [Fig. 4] may be used in the system 100 shown in [Fig. 1] or the system 300 shown in [Fig. 3].

Embodiments of the invention also provide a method for producing a cleaning and sterilizing agent, i.e. the alkaline ionized water with a PH value greater than 12. [Fig. 5] is a flowchart illustrating a method 500 for producing the cleaning and sterilizing agent according to one embodiment of the invention. In this embodiment, the system shown in [Fig. 1] or [Fig.3] may be used for producing the strong alkaline ionized water. The controller in the system is configured to control other components in the system and a power supply to conduct the electrolysis process to produce the alkaline ionized water with a PH value greater than 12, preferably in a range of 12.7 to 13.5.

In **block** 501, Electrolyte solution to be used in the electrolysis process is provided in the first tank which is fluid communicable with an anodic chamber of

each of at least one electrolytic cell through a first inlet and a first outlet of the anodic chamber; water to be ionized is provided in the second tank which is fluid communicable with an cathodic chamber of the each of the at least one electrolytic cell through a second inlet and a second outlet of the cathodic chamber. In this embodiment, the electrolyte solution is the potassium carbonate K2CO3 solution.

In this embodiment, before a voltage is applied to electrodes of each of the at least electrolytic cell, the electrolyte solution may be provided in the anodic chamber from the first tank/electrolyte tank through the first inlet of the anodic chamber and water to be ionized may be provided in the cathodic chamber of each of the at least electrolytic cell from the second tank through the second inlet of the cathodic chamber. In some embodiments of the invention, the transfer of the electrolyte solution may be stopped until the first tank is full or the solution in the first tank reaches a predetermined level; and the transfer of the water to be ionized may be stopped until the second tank is full or the water in the second tank reaches a predetermined level.

In **block** 502, the controller controls, based on a first predetermined PH value and a PH value measured in the second tank, or a predetermined time period, a first fluid circulation process conducted between the anodic chamber of the each of the at least one electrolytic cell and the first ~~rank~~tank; and a second fluid circulation process conducted between the cathodic chamber of the each of the at least one electrolytic cell and the second tank to produce the alkaline ionized water, i.e. the cleaning and sterilizing agent.

In this embodiment, the first predetermined PH value may be in a range of 12.7 to 13.5.

In this embodiment, the method may further include: measuring a PH value in the second tank using a first PH meter. Accordingly, the step of controlling the first and the second fluid circulation processes may further comprise: the controller stops the first and the second fluid circulation processes based on the first predetermined PH value and the PH value measured in the second tank. For example, the controller stops the first and the second fluid circulation processes when the PH value measured in the second tank is not less than the first predetermined PH value.

In this embodiment, the step of controlling the first and the second fluid circulation processes may further comprise: controlling, by the controller, the first and the second fluid circulation processes through controlling fluid transfer devices arranged for the first and the second fluid circulation processes, wherein a fluid transfer device may include a pipeline, at least one valve and a pump. For example, when the system 300 in [Fig. 3] is used in the electrolysis process, the controller 304 may control the first fluid circulation process through controlling a fluid transfer device including a pipeline, valve 2 and pump 3; and control the second fluid circulation process through controlling a fluid transfer device including a pipeline, valve 4, valve 5 and a pump 4.

The PH value of the electrolyte solution used in the electrolysis process will affect the speed of the electrolysis process. Specifically, the higher the PH value

of the electrolyte solution in the first tank is, less time the electrolysis process will take to produce alkaline ionized water with a PH value not less than the first predetermined value. Therefore, to further improve the efficiency of the electrolysis process, an electrolyte solution with a PH value not less than a second predetermined PH value, e.g. 9, may be provided in the first tank. In this embodiment, the electrolyte solution in the first tank may be provided/generated by transferring concentrated electrolyte solution from a third tank and mix the concentrated electrolyte solution with water to obtain the electrolyte solution with a PH value not less than the second predetermined PH value.

In this embodiment, to ensure the PH value in the first tank is not less than the second predetermined PH value during the electrolysis process or after each production cycle of the electrolyte process, the method may further comprise:

measuring a PH value in the first tank using a second PH meter, and controlling, by the controller, discharge of concentrated electrolyte solution from the third tank to the first tank based on the PH value measured by the second PH meter and the second predetermined PH value. For example, the controller controls to discharge the concentrated electrolyte solution from the third tank to the first tank when the PH value measured by the second PH meter is less than the second predetermined PH value.

It should be noted that the step of controlling discharge of the concentrated electrolyte solution may be conducted after the first and the second fluid circulation processes are stopped, i.e. after a production cycle of the agent is completed or

before a next production cycle is started. Alternatively, the controller may control the discharge of the concentrated electrolyte solution based on a predetermined time interval. It should be noted that in some embodiments of the invention, if the first tank is full of depleted electrolyte solution during the electrolysis process, to add additional concentrated electrolyte solution into the first tank, a certain amount of depleted electrolyte solution in the first tank needs to be discharged either before or simultaneously with adding the concentrated electrolyte solution.

To further ensure good quality control and production consistency during the electrolysis process, in this embodiment, RO water produced by a 5-stage filtering process and stored in a RO water tank may be used in the electrolysis process as the water to be ionized and the water used for producing electrolyte solution in the first tank. The RO water may be transferred to the second tank through a first fluid transfer device until the second tank is full. The water level in the second tank may be detected by water level sensors installed in the second tank.

In this embodiment, the electrolyte solution in the first tank may be provided by transferring the RO water from the RO water tank and the concentrated electrolyte solution from the third tank to obtain the electrolyte solution with a PH value not less than the second predetermined PH value. The amount of concentrated electrolyte solution from the third tank and/or the amount of RO water from the RO water tank to the first tank may be controlled by the controller based on the second predetermined PH value and the PH value measured in the first tank. Alternatively, the controller may control the amount of concentrated electrolyte solution from the third tank and/or the amount of RO water from the RO

water tank to the first tank based on a predetermined discharge time. The predetermined discharge time may be obtained based on experiments or experience.

In this embodiment, the controller may control the transfer of the RO water to the second tank and the first tank, and the transfer of the concentrated electrolyte solution to the first tank through a corresponding fluid transfer device. A fluid transfer device may include a pipeline, at least one valve and a pump.

It should be noted that the RO water and the concentrated electrolyte solution may be transferred to the first tank concurrently. The amount of the concentrated electrolyte solution transferred to the first tank may be controlled based on a user input, e.g. the second predetermined PH value, i.e. the minimum PH value in the electrolyte/first tank or a predetermined electrolyte discharge time period, through the user interface.

In this embodiment, the concentrated electrolyte solution in the third tank may be produced by adding electrolyte powder in water in the third tank and dissolving the powder in water sufficiently using a stirrer. The stirring speed and time may be controlled by the controller. The solution in the third tank may be replenished manually or automatically from an external solvent tank.

In this embodiment, before conducting the first and the second fluid circulation processes, the controller may control a power supply to apply a voltage to the electrodes of the electrolytic cell to start the electrolysis process. Further, before controlling the power supply to start the electrolysis process, the controller

may check all of the water level sensors, especially the water level sensors in the first and the second tanks, and the first and the second PH meters, and a leakage detector if any and confirm that the system is ready for the electrolysis process.

Although in this embodiment of the invention, a controller may be provided to automatically control each step of the electrolysis process, in some embodiments of the invention, some steps of the process may be controlled by a user manually.

If the system used for the electrolysis process includes a plurality of electrolytic cells. The group of electrolytic cells may be connected in parallel so that more water can be ionized at the same time, and thus increasing the production rate. The step of controlling the first and second fluid circulation processes may include: controlling, by the controller, the first fluid circulation process conducted between an anodic chamber of each of the plurality of electrolytic cells and the first ~~rank~~tank; and a second fluid circulation process conducted between a cathodic chamber of each of the plurality of electrolytic cells and the second tank to produce the ionized alkaline water, wherein each of the electrolytic cells is arranged to be in fluid communicable with the first tank through a common first inlet pipeline and a common first outlet pipeline; and to be in fluid communicable with the second tank through a common second inlet pipeline and a common second outlet pipeline, wherein the common first inlet pipeline is configured to be in fluid communication with the first inlet of each electrolytic cell; the common first outlet pipeline is configured to be in fluid communication with the first outlet of each electrolytic cell, wherein the common second inlet pipeline is

configured to be in fluid communication with the second inlet of each electrolytic cell; and the common second outlet pipeline is configured to be in fluid communication with the second outlet of each electrolytic cell.

During the electrolysis process, the current flowing through the electrolytic cell may be continuously monitored. The controller may control the voltage applied on the electrolytic cell by the power supply so as to maintain the current through the electrolytic cell at an optimum value of the capacity of the electrolytic cell.

After the electrolysis process, the ionized water in the second tank may be transferred to a storage tank through a fluid transfer device including a pipeline, a pump and a valve. When the ionized water is discharged from second tank, one cycle of the electrolysis process is completed.

Before the start of a next production cycle of the electrolysis process, the controller will check the PH value in the first tank. If the PH value measured in the first tank by the first PH meter is below the second predetermined PH value, e.g. 9, the controller will control the first tank to discharge a certain amount of depleted electrolyte solution and control the third tank to discharge a certain amount of concentrated electrolyte to the first tank automatically. It should be noted that the speed of the production process is dependent on the electrolyte PH alkalinity. The higher the pH value of the electrolyte solution is, the faster the RO water will be ionized to the first predetermined PH value. The speed is also dependent on the voltage applied to the electrolytic cell electrodes, the higher the voltage is, the higher the speed is.

With the system and method proposed by embodiments of the invention, in the process of producing the agent or strong alkaline ionized water (SACW), only a small amount of spent electrolyte solution (PH <9) will be discharged from the electrolyte tank which will be replenished from the solvent/third tank. Therefore, this process is environmentally friendly since less wastewater will be discharged in the electrolysis process. Experiments have shown that other than the small amount of water that is discharged when producing RO water, the electrolysis process has only about 250ml* of discharge with every 5L* of SACW produced.

When there is no SACW production, user can activate automatic cleaning of the whole system. All tanks, valves and ionizers may be flushed with RO water to clear away the electrolyte residues.

As mentioned above, the strong alkaline ionized water proposed and produced in embodiments of the invention is useful in removing stubborn stain such as oil and dirt from items made of stainless steel, plastics, glass, car rims. It is also useful on furniture, flooring made of laminate and upholstery made from fabric. The performance of the agent/strong alkaline ionized water is compared with conventional industrial cleaning agent (Sodium hydroxide NaOH 15% concentration) through an experiment. The experiment results show that the strong alkaline ionized water produced in embodiments of the invention is more effective for cleaning or removing residue oil and sediments. In addition, it is observed that the strong alkaline ionized water is able to break down fragments of sediment into much finer suspending particles.

As will be appreciated from the above, embodiments of the invention provide a cleaning and sterilizing agent consisting of strong alkaline ionized water with a PH value greater than 12, preferably in a range of 12.7 to 13.5. As the proposed agent comprises only pure wate and less than 1% of food grade, it is odourless, colourless, alcohol-free and does not contain any harmful chemicals. Tests and experiments have proved that this agent is environmentally friendly, safe, non-toxic, and effective for various cleaning and sterilizing purposes. It is effective against stubborn stain, grease, and oil and at the same time, can kill greater than 99.90% germs including bacteria and human coronavirus.

Embodiments of the invention also provide a method and system for producing the agent. Different from the existing technology for producing alkaline ionized water in which the mobility of the ions in the electrolyte cell is increased by an additional heating mechanism, in embodiments of the invention, two fluid circulation processes are conducted to increase the mobility of the ions diffusion in the electrolytic cell. With the fluid circulation processes, it would be easier to control the PH value of the produced alkaline ionized water, and the PH value of the produced alkaline ionized water may be greater than 12 and even up to 13.5.

It is to be understood that the embodiments and features described above should be considered exemplary and not restrictive. Many other embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the invention. The scope of the invention should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. Furthermore, certain terminology

has been used for the purposes of descriptive clarity, and not to limit the disclosed embodiments of the invention.

Claims

~~[Claim 1] A cleaning and sterilizing agent, the agent consisting of greater than 99% of water and less than 1% of potassium hydroxide (KOH), and having a PH value greater than 12.~~

~~[Claim 2] The agent according to claim 1, wherein the agent is produced through an electrolysis/ionization process.~~

~~[Claim 3] The agent according to claim 1 or claim 2, wherein the agent has a PH value in a range of 12.7 to 13.5.~~

~~[Claim 4] The agent according to any one of claim 1 to claim 3, wherein the agent comprises 0.8% of potassium hydroxide.~~

~~[Claim 5] Use of the agent according to any one of claim 1 to claim 4 for cleaning purpose, killing bacteria and human coronavirus.~~

[Claim ~~6~~1] A system for producing a cleaning and sterilizing agent ~~according to any one of claim 1 to claim 5~~, the system comprising at least one electrolytic cell, each including an anodic chamber with a first inlet and a first outlet and an cathodic chamber with a second inlet and a second outlet, a first tank, a second tank and a controller, wherein

the first tank is configured to hold an electrolyte solution and be fluid communicable with the anodic chamber of each of the at least one electrolytic cell

through the first inlet and the first outlet of the anodic chamber, wherein the electrolyte solution is a potassium carbonate ~~k2CO3~~ solution;

the second tank is configured to hold water to be ionized and be fluid communicable with the cathodic chamber of the each of the at least one electrolytic cell through the second inlet and the second outlet of the cathodic chamber; and

the controller is configured to control, based on a first predetermined PH value and a PH value measured in the second tank, or a predetermined time period, a first fluid circulation process conducted between the anodic chamber of the each of the at least one electrolytic cell and the first tank; and a second fluid circulation process conducted between the cathodic chamber of the each of the at least one electrolytic cell and the second tank to produce alkaline ionized water.

[Claim 2] The system according to claim 1, wherein the each of the at least one electrolytic cell includes a cation semi-permeable membrane between the anodic chamber and the cathodic chamber to allow ion exchange between the anodic chamber and the cathodic chamber.

[Claim ~~7~~3] The system according to claim ~~6~~1 or claim 2, further comprising a first PH meter configured to measure a PH value in the second tank, wherein the controller is further configured to stop the first and the second fluid circulation processes when the PH value measured by the first PH meter is not less than the first predetermined PH value.

[Claim ~~8~~4] The system according to any one of claims ~~7~~1 to 3, wherein the controller is further configured to control the first and the second fluid circulation processes through controlling fluid transfer devices arranged for the first and the second fluid circulation processes, wherein a fluid transfer device includes a pipeline, at least one valve and a pump.

[Claim ~~9~~5] The system according to any one of claims ~~6~~1 to 4~~claim 8~~, wherein the first tank is further configured to hold an electrolyte solution with a PH value not less than a second predetermined PH value.

[Claim ~~10~~6] The system according to claim ~~9~~5, further comprising a second PH meter configured to measure a PH value in the first tank, wherein the controller is further configured to control discharge of a concentrated electrolyte solution from a third tank to the first tank based on the PH value measured by the second PH meter and a second predetermined PH value.

[Claim ~~11~~7] The system according to claim ~~10~~6, wherein the controller is further configured to control the discharge of the concentrated electrolyte solution from the third tank based on the PH value measured by the second PH meter and the second predetermined PH value after the first and the second fluid circulation processes are stopped.

[Claim ~~12~~8] The system according to any one of claims 1 to 7~~6 to claim 11~~, wherein the water to be ionized is Reverse Osmosis (RO) water, and the system further comprises a RO water tank configured to hold RO water, and a first fluid transfer device arranged for transferring the RO water from the RO tank to the

second tank, wherein the controller is further configured to control transfer of the RO water from the RO water tank to the second tank through controlling the first fluid transfer device.

[Claim ~~13~~9] The system according to claim ~~12~~8, wherein the controller is further configured to control transfer of the RO water from the RO water tank to the first tank to produce the electrolyte solution based on the PH value measured by the second PH meter and the second predetermined PH value.

[Claim ~~14~~10] The system according to claim ~~13~~9, wherein the system further comprises a second fluid transfer device arranged for transferring the RO water from the RO water tank to the first tank, and the controller is further configured to control the transfer of the RO water from the RO water tank to the first tank by controlling the second fluid transfer device.

[Claim ~~15~~11] The system according to any one of claims 1 to 10 ~~6 to claim 14~~, wherein the system comprises a plurality of electrolytic cells, wherein each of the electrolytic cells is further configure to be fluid communicable with the first tank through a first common first inlet pipeline and a common first outlet pipeline; and to be fluid communicable with the second tank through a common second inlet pipeline and a common second outlet pipeline, wherein the common first inlet pipeline is configured to be in fluid communication with the first inlet of each electrolytic cell; the common first outlet pipeline is configured to be in fluid communication with the first outlet of each electrolytic cell, wherein the common second inlet pipeline is configured to be in fluid communication with the second

inlet of each electrolytic cell; the common second outlet pipeline is configured to be in fluid communication with the second outlet of each electrolytic cell.

[Claim ~~16~~12] The system according to any one of claims 1 to 11 ~~6 to claim 15~~, wherein the controller is further configured to receive user inputs through a user interface, wherein the user inputs include the first predetermined PH value or the predetermined time period.

[Claim ~~17~~13] A method for producing a liquid cleaning and sterilizing agent ~~according to any one of claim 1 to claim 5~~, the method comprising:

providing an electrolyte solution in a first tank which is fluid communicable with an anodic chamber of each of at least one electrolytic cell through a first inlet and a first outlet of the anodic chamber, wherein the electrolyte solution is potassium carbonate ~~K2CO3~~ solution;

providing water to be ionized in a second tank which is fluid communicable with a cathodic chamber of the each of the at least one electrolytic cell through a second inlet and a second outlet of the cathodic chamber; and

controlling, by a controller, based on a first predetermined PH value and a PH value measured in the second tank, or a predetermined time period, a first fluid circulation process conducted between the anodic chamber of the each of the at least one electrolytic cell and the first ~~rank~~tank; and a second fluid circulation process conducted between the cathodic chamber of the each of the at least one electrolytic cell and the second tank to produce alkaline ionized water.

[Claim 14] The method according to claim 13, wherein the each of the at least one electrolytic cell includes a cation semi-permeable membrane between the anodic chamber and the cathodic chamber to allow ion exchange between the anodic chamber and the cathodic chamber.

[Claim ~~18~~15] The method according to claim ~~17~~13 or claim 14, further comprising: measuring a PH value in the second tank using a first PH meter,

wherein the step of controlling the first and the second fluid circulation processes comprises:

stopping, by the controller, the first fluid circulation process and the second fluid circulation process when the PH value measured by the first PH meter is not less than the first predetermined PH value; and

optionally controlling, by the controller, the first and the second fluid circulation processes through controlling fluid transfer devices arranged for the first and the second fluid circulation processes, wherein the fluid transfer device includes a pipeline, at least one valve and a pump.

~~[Claim 19] The method according to claim 18, wherein the step of controlling the first and the second fluid circulation processes comprises: controlling, by the controller, the first and the second fluid circulation processes through controlling fluid transfer devices arranged for the first and the second fluid circulation processes, wherein a fluid transfer device includes a pipeline, at least one valve and a pump.~~

[Claim ~~20~~16] The method according to any one of claims 13 to 15~~ 17 to claim 19~~, wherein the providing an electrolyte solution in a first tank comprises: providing an electrolyte solution with a PH value not less than a second predetermined PH value in the first tank;~~.~~

~~[Claim 21] The~~the method ~~according to claim 20,~~ further comprising:

measuring ~~a~~ the PH value in the first tank using a second PH meter; and

controlling, by the controller, discharge of a concentrated electrolyte solution from a third tank to the first tank based on the PH value measured by the second PH meter and the second predetermined PH value.

[Claim ~~22~~17] The method according to claim ~~21~~16, wherein the step of controlling discharge of the concentrated electrolyte solution comprises: controlling, by the controller, the discharge of the concentrated electrolyte solution from the third tank based on the PH value measured by the second PH meter and the second predetermined PH value after the first and the second fluid circulation processes are stopped.

[Claim ~~23~~18] The method according to any one of claims 13 to 17~~ 17 to claim 22~~, wherein the step of providing water to be ionized in the second tank comprises: receiving, by the second tank, RO water transferred from a RO water tank through a first fluid transfer device, wherein the method further comprises: controlling, by the controller, transfer of RO water from the RO water tank to the second tank through controlling the first transfer device.

[Claim ~~24~~19] The method according to claim ~~23~~18, further comprising: controlling, by the controller, transfer of the RO water from the RO water tank to the first tank to produce the electrolyte solution based on the PH value measured by the second PH meter and the second predetermined PH value; and

optionally controlling, by the controller, transfer of the RO water from the RO water thank to the first tank by controlling a second fluid transfer device arranged for transferring the RO water from the RO water tank to the first tank.

~~[Claim 25] The method according to claim 24, further comprising: controlling, by the controller, transfer of the RO water from the RO water thank to the first tank by controlling a second fluid transfer device arranged for transferring the RO water from the RO water tank to the first tank.~~

[Claim ~~26~~20] The method according to any one of claims 13 to 19 ~~17 to claim 25~~, wherein the step of controlling the first and the second fluid circulation processes, comprises:

controlling, by the controller, the first fluid circulation process conducted between an anodic chamber of each of a plurality of electrolytic cells and the first ~~rank~~tank; and a second fluid circulation process conducted between a cathodic chamber of each of a plurality of electrolytic cells and the second tank to produce the alkaline ionized water, wherein each of the electrolytic cells is arranged to be fluid communicable with the first tank through a common first inlet pipeline and a common first outlet pipeline; and to be fluid communicable with the second tank through a common second inlet pipeline and a common second

outlet pipeline, , wherein the common first inlet pipeline is configured to be in fluid communication with the first inlet of each electrolytic cell; the common first outlet pipeline is configured to be in fluid communication with the first outlet of each electrolytic cell, wherein the common second inlet pipeline is configured to be in fluid communication with the second inlet of each electrolytic cell; the common second outlet pipeline is configured to be in fluid communication with the second outlet of each electrolytic cell; and

optionally the method .

~~[Claim 27] The method according to any one of claim 17 to claim 26,~~ further comprising: receiving, by the controller, user inputs through a user interface, wherein the user inputs include the first predetermined PH value or the predetermined time period.