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Name: Liyu Li
Title: Chairman
Authorized signer for COUGAR CREEK TECHNOLOGIES, LLC

Date: 10-11-2021

METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROUS ACID SOLUTION

CROSS-REFERENCE TO RELATED APPLICATIONS

This patent application claims priority to U.S. Patent Application Serial No. 17/089,537, filed November 4, 2020, which is incorporated herein by reference.

FIELD

The present invention is directed to the area of methods and systems for the production of an aqueous hypochlorous acid (HClO) solution. The present invention is also directed to methods and systems for the production of hypochlorous acid by consumers.

BACKGROUND

Hypochlorous acid has been found to have bactericidal and virucidal properties. Compared to sodium hypochlorite, which is often used as sterilizing agent, hypochlorous acid is said to be over 80 times more effective. Hypochlorous acid can keep hands smooth, is eco-friendly, and can be used directly to wash vegetables, fruits, and tableware. It can also effectively eliminate many pesticide residues on the surface of vegetables. Hypochlorous acid is approved by the US Food and Drug Administration (FDA) and recommended by Japan's Ministry of Health, Labour and Welfare as a food-grade germicidal solution.

BRIEF SUMMARY

One embodiment is a method for making an aqueous hypochlorous acid (HClO) solution that includes electrolyzing a solution of sodium chloride to produce a solution of sodium hypochlorite; and producing the aqueous hypochlorous acid solution by adjusting a pH of the solution of sodium hypochlorite to a value within a range of 3 to 8 by adding a selected weak acid to the solution of sodium hypochlorite to produce a buffer including the selected weak acid and a salt of the selected weak acid.

In at least some embodiments, the aqueous hypochlorous acid solution has no more than 500 ppm hypochlorous acid. In at least some embodiments, the method further includes adding a basic salt or a base to the solution of sodium chloride. In at least some embodiments, the basic salt or base reduces or absorbs chlorine gas generated during the electrolysis. In at least some embodiments, the basic salt or base is selected from sodium bicarbonate, sodium carbonate, or sodium hydroxide.

In at least some embodiments, the selected weak acid is acetic acid and the buffer is a combination of acetic acid and sodium acetate. In at least some embodiments, the buffer in the aqueous hypochlorous acid solution as a molar ratio of acetic acid to sodium acetate in a range from 1:100 to 100:1.

In at least some embodiments, the method further includes diluting the solution of sodium hypochlorite. In at least some embodiments, the solution of sodium hypochlorite after the electrolyzing has at least 500 ppm sodium hypochlorite. In at least some embodiments, the solution of sodium hypochlorite after the electrolyzing has at least 1000 ppm sodium hypochlorite.

In at least some embodiments, producing the aqueous hypochlorous acid solution includes producing the aqueous hypochlorous acid solution by adjusting a pH of the solution of sodium hypochlorite to a value within a range of 4 to 6. In at least some embodiments, electrolyzing the solution of sodium chloride includes electrolyzing the solution of sodium chloride in an electrolysis cell including at least one positive electrode and at least one negative electrode without a membrane or separator between the at least one positive electrode and the at least one negative electrode. In at least some embodiments, the method further includes transferring the solution of sodium hypochlorite from the electrolysis cell after the electrolyzing and, after the transferring, receiving the selected weak acid in the electrolysis cell. In at least some embodiments, the selected weak acid removes calcium or magnesium deposits one the electrode surface. In at least some embodiments, un-softened water is used in the system for solution preparation and for dilution.

In at least some embodiments, the method further includes generating, storing or re-generating a solution of sodium hypochlorite in the electrolysis cell while the

hypochlorous acid product in the product tank is being consumed. In at least some embodiments, the method further includes regenerating the sodium hypochlorite solution by re-electrolyzing the sodium hypochlorite solution after storing for a predetermined time period, wherein the predetermined time period is at least twelve hours.

Another embodiment is a system for making an aqueous hypochlorous acid (HClO) solution. The system includes an electrolysis cell; a water tank or a coupling arrangement configured for coupling to an external water source; an acid tank configured for receiving a selected weak acid; a NaCl tank configured for receiving an aqueous sodium chloride solution; a product tank; conduits individually coupling the water tank, acid tank, NaCl tank, and product tank to the electrolysis cell; and a controller configured and arranged to perform actions when the NaCl tank contains the sodium chloride solution, the acid tank contains the selected weak acid, water is in the water tank or the system is coupled to a water source using the coupling arrangement, the actions including: directing a portion of the aqueous sodium chloride solution from the NaCl tank to the electrolysis cell; electrolyzing the portion of the solution of sodium chloride to produce a solution of sodium hypochlorite in the electrolysis cell; directing the solution of sodium hypochlorite into the product tank; and directing a portion of the selected weak acid in the acid tank into the solution of sodium hypochlorite to produce the aqueous hypochlorous acid solution by adjusting a pH to a value within a range of 3 to 8 by adding the selected weak acid to the solution of sodium hypochlorite to form a buffer using the selected weak acid and a salt of the selected weak acid.

In at least some embodiments, the system is configured to produce the aqueous hypochlorous acid solution by providing acetic acid in the acid tank and a NaCl solution in the NaCl tank. In at least some embodiments, the system is further configured to produce the aqueous hypochlorous acid when a base or a basic salt is provided in the sodium chloride solution to reduce production of chlorine gas, wherein the base or basic salt is selected from sodium hydroxide, sodium carbonate, or sodium bicarbonate.

In at least some embodiments, the electrolysis cell includes at least one positive electrode and at least one negative electrode without a membrane or separator between the at least one positive electrode and the at least one negative electrode. In at least some embodiments, at least one of the at least one positive electrode or the at least one negative

electrode includes ruthenium and iridium. In at least some embodiments, at least one of the at least one positive electrode or the at least one negative electrode includes titanium.

In at least some embodiments, the system further includes a housing, wherein the electrolysis cell, water tank or coupling arrangement, acid tank, NaCl tank, product tank, and controller are disposed in the housing. In at least some embodiments, the system further includes at least one level indicator in at least one of the acid tank, NaCl tank, or product tank and coupled to the controller.

BRIEF DESCRIPTION OF THE DRAWINGS

Non-limiting and non-exhaustive embodiments of the present invention are described with reference to the following drawings. In the drawings, like reference numerals refer to like parts throughout the various figures unless otherwise specified.

For a better understanding of the present invention, reference will be made to the following Detailed Description, which is to be read in association with the accompanying drawings, wherein:

FIG. 1 is a schematic diagram of one embodiment of system for making an aqueous HClO solution, according to the invention; and

FIG. 2 is a flowchart of a one embodiment of method for making an aqueous HClO solution, according to the invention.

DETAILED DESCRIPTION

The present invention is directed to the area of methods and systems for the production of hypochlorous acid (HClO). The present invention is also directed to methods and systems for the production of hypochlorous acid by consumers.

Many commercial methods of HClO production involve brine electrolysis using a cell with a membrane. These commercial methods may be relatively complicated and only practical for commercial-scale applications. Production of hypochlorous acid has also been achieved on a commercial scale by adding an acid, such as hydrochloric acid, to sodium hypochlorite (NaClO) via a precious pH control process. For small-scale, on-site, and on-demand applications, NaClO and HCl are not always available. In addition, the precious pH control during the mixing process is required to prevent or reduce the

generation of toxic chlorine gas and may be difficult in non-industrial arrangements. A solution of sodium hypochlorite (NaClO) has been produced using a small, low cost electrochemical cell and a brine solution. However, sodium hypochlorite is more toxic to the human body.

Methods and systems for generating an aqueous hypochlorous acid solution are described herein. In at least some embodiments, the methods and systems can be used by consumers to produce the hypochlorous acid solution on a small-scale, on-site, or on-demand basis. In at least some embodiments, these methods and systems utilize readily available components, such as water, sodium chloride (NaCl), acetic acid (e.g., vinegar), and either sodium bicarbonate (e.g., baking soda), sodium carbonate (e.g., soda ash or washing soda), or sodium hydroxide (e.g., caustic soda or lye) to generate the hypochlorous acid. In at least some embodiments, the water is unsoftened.

The methods and systems described herein utilize the equilibrium of HClO and NaClO in aqueous solution where HClO is the dominate species in solutions with a pH between approximately 3 and approximately 7. In at least some embodiments, the methods and systems are configured to produce an aqueous hypochlorous acid solution with a pH in a range from 3 to 8, a range from 3.5 to 7, a range from 4 to 6.5, or a range from 4 to 6. HClO and NaClO typically reach equilibrium very quickly in solution. HClO exists stably at a pH range of at least 4 to 6.5.

To maintain the pH in the desired range, the aqueous hypochlorous acid solution has a buffer that includes a weak acid and a salt of the weak acid and which maintains the pH in the desired range. In at least some embodiments, the buffer includes acetic acid and a salt of acetic acid such as sodium acetate, aluminum acetate, ammonium acetate, or potassium acetate.

In at least some embodiments, the buffer can be formed by addition of a weak acid, such as acetic acid or the like, to the NaClO solution. The addition of acetic acid to the NaClO solution results in the formation of sodium acetate (which, in water, exists primarily in the form of sodium and acetate ions). Thus, in at least some embodiments, the buffer can be prepared using household chemicals, such as acetic acid (e.g., vinegar).

$$CH_3COOH \rightarrow CH_3COO^- + H^+ \quad pKa = 4.76.$$

In water, CH_3COONa : CH_3COOH in a 1:1 molar ratio gives a solution with pH of approximately 4.76. CH_3COONa : CH_3COOH in a 10:1 molar ratio gives a solution with pH of approximately 5.76.

In at least some embodiments, the resulting aqueous hypochlorous acid solution is stable for at least 5, 10, 15, 30, 60, or more days.

In at least some embodiments, a buffer of acetic acid and an acetate salt, such as sodium acetate, can reliably keep the pH within a range of 4 to 6.5 with a molar ratio of acetic acid to acetate salt in a range from 1:100 to 100:1. In at least some embodiments, no accurate volumetric control is needed for pH control due to the buffer.

In at least some embodiments, the addition of a soluble basic salt or base may further facilitate formation of the buffer. For example, the addition of soluble sodium bicarbonate, sodium carbonate, or sodium hydroxide to the acetic acid may further the formation of sodium acetate (which, in water, exists primarily in the form of sodium and acetate ions). In at least some embodiments, the soluble basic salt or base can be household chemicals, such as sodium bicarbonate ($NaHCO_3$), commonly known as baking soda, sodium carbonate (Na_2CO_3), commonly known as soda ash or washing soda, or sodium hydroxide (NaOH), commonly known as caustic soda or lye. For example,

$$CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$$

In at least some embodiments, adding the basic salt or base, such as, for example, $NaHCO_3$, Na_2CO_3, or NaOH, for the buffer into the NaCl solution can reduce Cl_2 generation during the electrolysis of NaCl.

In at least some embodiments, the components of the buffer are introduced separately during the production of the HClO solution.

Methods and systems for preparing an aqueous HClO solution include generating a concentrated NaClO solution in an electrochemical device from a solution containing NaCl, adjusting the pH of the NaClO solution using a buffer to produce the HClO solution, and diluting the as-produced NaClO or HClO to a desired concentration using water (preferably, unsoftened water).

The methods and systems include the electrochemical production of an aqueous NaClO solution from an aqueous NaCl solution according to the following equation:

$$NaCl + H_2O \rightarrow NaClO + H_2$$

In at least some embodiments, the electrochemical production of aqueous NaClO is thought to proceed according to the following equations (although the invention does not rely on any particular mechanism or sequence of reactions):

$$2NaCl + 2H_2O \rightarrow Cl_2 + 2NaOH + H_2 \text{ (electrolysis)}$$

$$Cl_2 + H_2O \rightarrow HClO + HCl \text{ (disproportionation)}$$

$$HClO + HCl + 2NaOH \rightarrow NaClO + NaCl + 2H_2O \text{ (neutralization).}$$

Figure 1 illustrates one embodiment of a system 100 for production of an aqueous HClO (hypochlorous acid) solution. The system 100 includes a water source, such as water tank 102 or a coupling arrangement that can be coupled to a stream of water from an external source; a sodium chloride source, such as NaCl tank 104 containing an aqueous solution of sodium chloride and, optionally, the basic salt or base for reducing the generation of Cl_2 gas; a weak acid source, such as acid tank 106 containing the weak acid that forms the buffer; an electrolysis cell 108; and a product tank 110. Any of the tanks can be replaced by any other suitable reservoir or a coupling arrangement that can be coupled to a continuous or intermittent stream source.

The system 100 also includes a number of pumps 112 and various conduits 116, such as tubing or the like to carry the reactants and other components of the HClO solution, as well as the solution itself. Any other suitable mechanisms, methods, or techniques for flowing the components from the various sources to the electrolysis cell 108 and the product tank 110 can be used. For example, optional check valves may be used to prevent flow in the wrong directions. The HClO solution can be obtained at an outlet 118.

The system 100 also includes a control unit 122 that operates the system in general including the pumps 112, as needed. In at least some embodiments, the control

unit 122 can include one or more user operable components, such as switches, buttons, a touchscreen, or the like to permit user control of the system 100.

The system 100 may include an optional filter 120 to filter the water from the water tank 102. In at least some embodiments with a filter 120, there may also be a conduit from the water tank 102 to the valve 114 that bypasses the filter 120. The pumps 112 can be individually any suitable type of pump including, but not limited to, peristaltic pumps, diaphragm pumps, centrifugal pumps, or the like. The pumps 112 can be all the same type of pump or different types of pumps.

In at least some embodiments, one or more of the water tank 102, NaCl tank 104, acid tank 106, or product tank 110 can include a level gauge 124 to monitor the level of the respective solution or component in that tank. In at least some embodiments, the control unit 122 monitors the level gauge(s) 124 and, preferably, alerts a user if any level gauge drops below a predetermined level or rises above a predetermined level. Level gauges 124 in the water tank 102, NaCl tank 104, or acid tank 106 may indicate when additional source materials (e.g., water, NaCl, or weak acid) are needed. A level gauge 124 in the product tank 110 can indicate how much hypochlorous acid solution is presently available. In at least some embodiments, the product tank 110 may include one level gauge to monitor or warn for low fluid level and another level gauge to monitor or warn for high fluid level.

In at least some embodiments, the product tank 110 (or any other tank) may include a pH gauge 126. In at least some embodiments, the control unit 122 monitors the pH gauge 126. In at least some embodiments, the control unit 122 may alert a user if any pH gauge is outside a desired pH range and the control unit 122 may direct the user to dispose of the contents of the product tank 110. In at least some embodiments, the control unit 122 may automatically (or under user direction) pump the weak acid from the acid tank 106 or the solution containing the basic salt from the NaCl tank 104 to adjust the pH.

Any suitable electrolysis cell 108 with two or more electrodes 109a, 109b can be used. In at least some embodiments, the electrolysis cell 108 does not include a membrane or separator between the electrodes 109a, 109b. In at least some

embodiments, the surface of the positive electrode(s) 109a or negative electrode(s) 109b contains ruthenium, iridium, or any combination thereof. In at least some embodiments, the surface of the negative electrode(s) 109b contains platinum. In at least some embodiments, a bulk material of the positive and negative electrode(s) 109a, 109b is titanium, although any other suitable metal, alloy, or combination thereof can be used.

In at least some embodiments, the system 100 can be disposed in a single housing 130. In at least some embodiments, the system 100 and housing 130 can be portable. In at least some embodiments, as indicated above, instead of a water tank 102 (or other tank), the system 100 may include a coupling arrangement to couple to a streaming source of water (or other component). In at least some embodiments, one or more of the water tank 102, acid tank 106, NaCl tank 104, or product tank 110 can be disposed outside the housing 130.

Figure 2 is a flowchart of operation of the system to produce an aqueous solution of HClO. In step 202, a portion of the NaCl solution from the NaCl tank 104 is pumped into the electrolysis cell 108. In at least some embodiments, the NaCl solution includes a basic salt or base (for example, sodium bicarbonate, sodium carbonate, or sodium hydroxide) to reduce the generation of Cl_2 gas during the electrolysis. In at least some embodiments, the NaCl solution includes at least 5, 10, 20, 30, 50, 100, 200, or 300 grams (or more) of NaCl per liter of water. In at least some embodiments, the NaCl solution includes, for example, 0.1, 0.25, 0.5, or 1 gram of the basic salt or base per liter of the NaCl solution. In at least some embodiments, pre-prepared concentrated NaCl solution and a weak acid solution are used to prepare the NaCl solution and the weak acid solution in tanks 104 and 106.

In step 204, the NaCl solution is electrolyzed in the electrolysis cell 108 to produce an aqueous NaClO solution as described above. In at least some embodiments, the concentration of NaClO in the aqueous NaClO solution produced in the electrolysis cell 108, prior to dilution, is at least 500, 1000, or 5000 ppm. In at least some embodiments, the on-site generation of high concentration NaClO via electrolysis of high concentration NaCl is safe and efficient due to high concentration of the NaCl reactant and high solution conductivity. In at least some embodiments, the consumption of NaCl is no more than 0.4, 0.5, or 1 gram of NaCl per liter of aqueous HClO solution.

In step 206, the NaClO solution is pumped into the product tank 110 and, in step 208, the NaClO solution is diluted using water from the water tank 102. Steps 206 and 208 can be performed in any order so that the NaClO solution is diluted before or after being pumped into the product tank 110. In some embodiments, step 208 is skipped, and dilution occurs during later steps.

In step 210, after the electrolysis cell 108 is emptied, the weak acid from the acid tank 106 flows into the electrolysis cell 108 and, optionally, at least partially cleans the electrolysis cell of deposits such as calcium carbonate or magnesium carbonate residue. In at least some embodiments, the weak acid in the acid tank 106 is acetic acid and has a molarity of at least 0.1 or 0.3 M and may be in the range of 0.1 to 16 M. In optional step 212, the weak acid is diluted in the electrolysis cell 108 using water from the water tank 102.

In step 214, the acid, after optional dilution, is pumped into the product tank 110 and combined with the NaClO solution. The weak acid forms a buffer to adjust the pH to a range from 3 to 8, a range from 3.5 to 7, a range from 4 to 6.5, or a range from 4 to 6 to produce the aqueous HClO solution. In at least some embodiments, the dilution of the NaClO or HClO solution during steps 208 and 214 is at least a factor of 25, 50, 75, 100, 150, or 200 or more.

The user can remove the aqueous HClO solution through the outlet 118. In at least some embodiments, the concentration of HClO in the aqueous HClO solution, after dilution in the product tank 110, is in a range from 1 to 500 ppm.

In at least some embodiments, the operation of the system 100 can be continuous with the steps in Figure 2 repeated on a continuous cycle. In at least some embodiments, the system 100 can be programmed so that the operation of the system 100 is repeated on a regular or periodic basis. In at least some embodiments, the system 100 can be programmed so that the operation of the system 100 is repeated based on measurements from the level gauge 124 in the product tank 110.

In at least some embodiments, the system 100 can store the concentrated NaClO solution or the diluted NaClO solution for periods of time (minutes, hours, or days) prior to introduction of the weak acid. In at least some embodiments, the concentrated NaClO

solution or the diluted NaClO solution can be stored in the electrolysis cell 108, the product tank 110, or another storage tank (not shown) or any combination thereof.

In at least some embodiments, the aqueous hypochlorous acid solution is kept in the product tank. When the aqueous hypochlorous acid solution is consumed, a NaClO solution for the next batch of the aqueous hypochlorous solution is generated in the electrolysis cell 108 as described above and is stored in the electrolysis cell until the NaClO solution is needed to produce the next batch of the aqueous hypochlorous acid solution. Then, the NaClO solution is transferred to the product tank, diluted, and weak acid is added to produce more of the aqueous hypochlorous acid solution. In at least some embodiments, there may be limit (for example, 12 or 24 hours) to the length of time that the NaClO solution can remain in the electrolysis cell before reverting, at least in part, to an NaCl solution via the reaction below. In at lease some embodiments, the NaClO/NaCl solution in the electrolysis cell is re-charged every 24 hours as described above, or may be re-charged every 12 to 120 hours, or may be re-charged before producing next batch hypochlorous product.

$$2NaClO \rightarrow 2NaCl + O_2$$

The above specification provides a description of the manufacture and use of the invention. Since many embodiments of the invention can be made without departing from the spirit and scope of the invention, the invention also resides in the claims hereinafter appended.

CLAIMS

What is claimed as new and desired to be protected by Letters Patent of the United States is:

1. A method for making an aqueous hypochlorous acid (HClO) solution, the method comprising

electrolyzing a solution of sodium chloride to produce a solution of sodium hypochlorite; and

producing the aqueous hypochlorous acid solution by adjusting a pH of the solution of sodium hypochlorite to a value within a range of 3 to 8 by adding a selected weak acid to the solution of sodium hypochlorite to produce a buffer comprising the selected weak acid and a salt of the selected weak acid.

2. The method of claim 1, wherein the aqueous hypochlorous acid solution has no more than 500 ppm hypochlorous acid.

3. The method of claim 1, further comprising adding a basic salt or a base to the solution of sodium chloride.

4. The method of claim 3, wherein the basic salt or base is selected from sodium bicarbonate, sodium carbonate, or sodium hydroxide.

5. The method of claim 1, wherein the selected weak acid is acetic acid and the buffer is a combination of acetic acid and sodium acetate.

6. The method of claim 5, wherein the buffer in the aqueous hypochlorous acid solution has a molar ratio of acetic acid to sodium acetate in a range from 1:100 to 100:1.

7. The method of claim 1, further comprising diluting the solution of sodium hypochlorite.

8. The method of claim 1, wherein the solution of sodium hypochlorite after the electrolyzing has at least 500 ppm sodium hypochlorite.

9. The method of claim 1, wherein the solution of sodium hypochlorite after the electrolyzing has at least 1000 ppm sodium hypochlorite.

10. The method of claim 1, wherein producing the aqueous hypochlorous acid solution comprises producing the aqueous hypochlorous acid solution by adjusting a pH of the solution of sodium hypochlorite to a value within a range of 4 to 6.

11. The method of claim 1, wherein electrolyzing the solution of sodium chloride comprises electrolyzing the solution of sodium chloride in an electrolysis cell comprising at least one positive electrode and at least one negative electrode without a membrane or separator between the at least one positive electrode and the at least one negative electrode.

12. The method of claim 11, further comprising transferring the solution of sodium hypochlorite from the electrolysis cell after the electrolyzing and, after the transferring, receiving the selected weak acid in the electrolysis cell.

13. The method of claim 11, further comprising generating, storing or re-generating a solution of sodium hypochlorite in the electrolysis cell while the hypochlorous acid product in the product tank is being consumed.

14. The method of claim 13, further comprising regenerating the sodium hypochlorite solution by re-electrolyzing the sodium hypochlorite solution after storing for a predetermined time period, wherein the predetermined time period is at least twelve hours.

15. A system for making an aqueous hypochlorous acid (HClO) solution, the system comprising:

an electrolysis cell;

a water tank or a coupling arrangement configured for coupling to an external water source;

an acid tank configured for receiving a selected weak acid;

a NaCl tank configured for receiving an aqueous sodium chloride solution;

a product tank;

conduits individually coupling the water tank, acid tank, NaCl tank, and product tank to the electrolysis cell; and

a controller configured and arranged to perform actions when the NaCl tank contains the sodium chloride solution, the acid tank contains the selected weak acid, water is in the water tank or the system is coupled to a water source using the coupling arrangement, the actions including:

directing a portion of the aqueous sodium chloride solution from the NaCl tank to the electrolysis cell;

electrolyzing the portion of the solution of sodium chloride to produce a solution of sodium hypochlorite in the electrolysis cell;

directing the solution of sodium hypochlorite into the product tank; and

directing a portion of the selected weak acid in the acid tank into the solution of sodium hypochlorite to produce the aqueous hypochlorous acid solution by adjusting a pH to a value within a range of 3 to 8 by adding the selected weak acid to the solution of sodium hypochlorite to form a buffer using the selected weak acid and a salt of the selected weak acid.

16. The system of claim 15, wherein the system is configured to produce the aqueous hypochlorous acid solution by providing acetic acid in the acid tank and a NaCl solution in the NaCl tank

17. The system of claim 16, wherein the system is further configured to produce the aqueous hypochlorous acid when a basic salt or a base is provided in the sodium chloride solution to reduce production of chlorine gas, wherein the basic salt or base is selected from sodium carbonate, sodium bicarbonate, or sodium hydroxide.

18. The system of claim 15, wherein the electrolysis cell comprises at least one positive electrode and at least one negative electrode without a membrane or separator between the at least one positive electrode and the at least one negative electrode

19. The system of claim 18, wherein at least one of the at least one positive electrode or the at least one negative electrode comprises ruthenium and iridium.

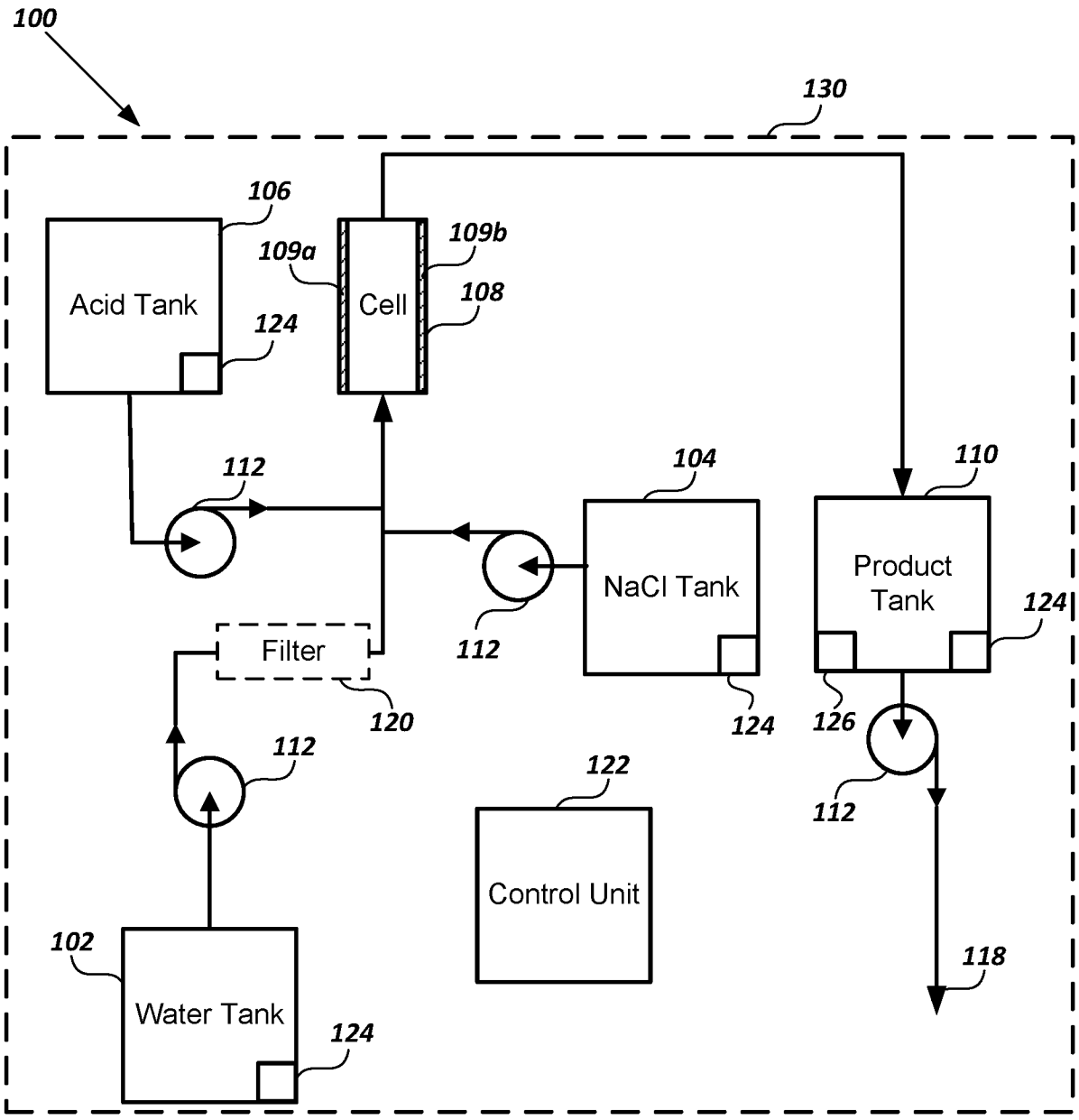
20. The system of claim 18, wherein at least one of the at least one positive electrode or the at least one negative electrode comprises titanium.

21. The system of claim 15, further comprising a housing, wherein the electrolysis cell, water tank or coupling arrangement, acid tank, NaCl tank, product tank, and controller are disposed in the housing.

22. The system of claim 15, further comprising at least one level indicator in at least one of the acid tank, NaCl tank, or product tank and coupled to the controller.

ABSTRACT

A method for making an aqueous hypochlorous acid (HClO) solution includes electrolyzing a solution of sodium chloride to produce a solution of sodium hypochlorite; and producing the aqueous hypochlorous acid solution by adjusting a pH of the solution of sodium hypochlorite to a value within a range of 3 to 8 by adding a selected weak acid to the solution of sodium hypochlorite to produce a buffer including the selected weak acid and a salt of the selected weak acid.


100
130
106
Acid Tank
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109a
Cell
109b
108
112
104
NaCl Tank
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124
110
Product Tank
124
126
112
Filter
120
112
122
Control Unit
102
Water Tank
124
118

Fig. 1

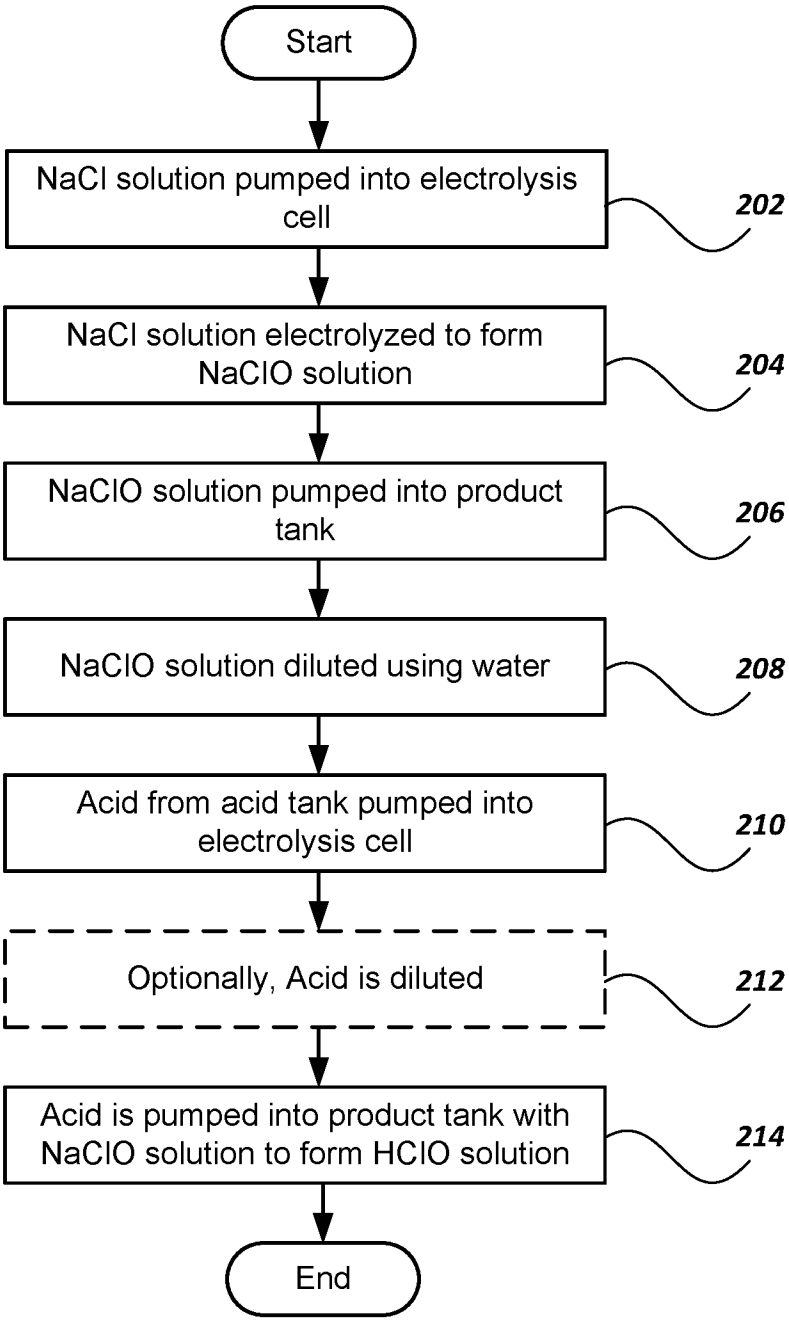
Start
NaCl solution pumped into electrolysis cell
202
NaCl solution electrolyzed to form NaClO solution
204
NaClO solution pumped into product tank
206
NaClO solution diluted using water
208
Acid from acid tank pumped into electrolysis cell
210
Optionally, Acid is diluted
212
Acid is pumped into product tank with NaClO solution to form HClO solution
214
End

Fig. 2

PTO-1382 (Rev. 01-2017)
Approved for use through 10/31/2022. OMB 0651-0021
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

TRANSMITTAL LETTER TO THE UNITED STATES RECEIVING OFFICE (RO/US)

Priority Mail Express Mailing Label No.: Via EFS	Date of Deposit: 12 October 2021
File Reference No.: CCLL-11-002.0	International Application No. (If known):
Customer Number[1]: 122997	Earliest Priority Date Claimed (dd/mm/yyyy): 04/11/2020
Title of Invention: METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLO	
Applicant: COUGAR CREEK TECHNOLOGIES, LLC	

[1] Customer Number will allow access to the application in Private PAIR but cannot be used to establish or change the correspondence address.

☑ This is a new International Application

SCREENING DISCLOSURE INFORMATION:

In order to assist in screening the accompanying international application for purposes of determining whether a license for foreign transmittal should and could be granted and for other purposes, the following information is supplied. (check all boxes as apply):

☐ The invention disclosed was **not** made in the United States of America.

☐ There is no prior U.S. application relating to this invention.

☑ The following prior U.S. application(s) contain subject matter which is related to the invention disclosed in the attached international application. *(NOTE: priority to these applications may or may not be claimed on the Request (form PCT/RO/101) and this listing does not constitute a claim for priority.)*

application no.	17/089,537	filed on November 4, 2020
application no.		filed on

☐ The present international application contains additional subject matter not found in the prior U.S. application(s) identified above. The additional subject matter is found on pages .....

and ☐ DOES NOT ALTER ☐ MIGHT BE CONSIDERED TO ALTER the general nature of the invention in a manner which would require the U.S. application to have been made available for inspection by the appropriate defense agencies under 35 U.S.C. 181 and 37 C.F.R. 5.15.

Itemized list of contents & entity status

Sheets of Request form: 4	Check no.:
Sheets of description (excluding sequence listing): 11	Return receipt postcard:
Sheets of claims: 4	Power of attorney: 1
Sheets of abstract: 1	Certified copy of priority document (specify):
Sheets of drawings: 2	PTO/SB15A or B or equivalent:
Sheets (paper or pdf) of sequence listing:	Other (specify): PCT Fee Calculation Sheet; Certificate of Electronic Filing
Sequence listing text file: ☐ CD or diskette ☐ via EFS-Web	

☐ Applicant asserts small entity status. See 37 CFR 1.27. If this written assertion is made by the applicant, all applicants must sign (37 C.F.R. §1.42)

☐ Applicant certifies micro entity status. See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.

The person signing this form is:	☐ Applicant	Bruce E. Black Name of person signing
	☑ Attorney/Agent Registration No. 41622	
	☐ Common Representative	/Bruce E. Black/ Signature

SEND TO: Mail Stop PCT, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant *(i.e.,* GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C.122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROUS ACID SOLUTION
First Named Inventor/Applicant Name:	COUGAR CREEK TECHNOLOGIES, LLC
Filer:	Bruce Black/Tiffany Kelly
Attorney Docket Number:	CCLL-11-002.0

Filed as Small Entity

Filing Fees for International Application (PCT) for filing in the US receiving office

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
TRANSMITTAL FEE	2601	1	130	130
PCT SEARCH FEE- NO PRIOR US APPL FILED	2602	1	1090	1090
INTL FILING FIRST 30PGS EFS WITHOUT ZIP	1701	1	1344	1344
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**2564**

Electronic Acknowledgement Receipt

EFS ID:	44013429
Application Number:	
International Application Number:	PCT/US21/54635
Confirmation Number:	9958
Title of Invention:	METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROUS ACID SOLUTION
First Named Inventor/Applicant Name:	COUGAR CREEK TECHNOLOGIES, LLC
Customer Number:	122997
Correspondence Address:	Bruce E. Black Branch Partners PLLC 600 University Street, Suite 620 - Seattle WA 98101 US - patentdocketing@branchpartners.law
Filer:	Bruce Black/Tiffany Kelly
Filer Authorized By:	Bruce Black
Attorney Docket Number:	CCLL-11-002.0
Receipt Date:	12-OCT-2021
Filing Date:	
Time Stamp:	20:44:44
Application Type:	International Application (PCT) for filing in the US receiving office
Patent Number:	

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$2564
RAM confirmation Number	E20210BK45081011
Deposit Account	603581
Authorized User	Tiffany Kelly

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

37 CFR 1.445(a)(1), (a)(2), (a)(4) and (b) (International application filing, processing and search fees)

37 CFR 1.17(m) (Acceptance of an unintentionally delayed claim for priority)

PCT Rule 14

PCT Rule 15

PCT Rule 16

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Misc. incoming letter from Applicant - IA	CCLL-11-002Cert.pdf	90285 17ccfe2ec937348bdb8277109931ed78403442bf	no	1
Warnings:					
Information:					
2		CCLL-11-002PCTRequest.pdf	425256 d48cc63a4b1b30fd9f0c9478d197861076985127	yes	5

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	RO/101 - Request form for new IA - Conventional	1	4
	RO/101 - Annex (fee calculation sheet)	5	5

Warnings:					
Information:					
3	Power of Attorney	CCLL-11-002POA.pdf	439765 18f2b6717f440b3642d3ff3b2e7d4099d3298cb4	no	1
Warnings:					
Information:					

4		CCLL_002_App_EFS.pdf	152309 5957df66f95adaa402220f94e3f3e65c045ef013	yes	16

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Specification	1	11
Claims	12	15
Abstract	16	16

Warnings:

Information:

5	Drawings-only black and white line drawings	CCLL_002_Drawings_EFS.pdf	628904 413ed7362cb1bd77c84157ae34bb0129713731a9	no	2

Warnings:

Information:

6	PCT-Transmittal Letter	CCLL-11-002PCTTransmittal.pdf	517461 926ea0fc3d0a3bbc5d936a25480f191566da8a2f	no	2

Warnings:

Information:

7	Fee Worksheet (SB06)	fee-info.pdf	44061 eb27b19dcac15a341e997b32e936f098c2760fee	no	2

Warnings:

Information:

Total Files Size (in bytes):	2298041

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Application No. (if known): Not Yet Assigned | Attorney Docket No.: CCLL-11-002.0

Certificate of Electronic Filing Under 37 C.F.R. § 1.8

I hereby certify that this correspondence is being transmitted via the Office electronic filing system in accordance with 37 C.F.R. § 1.6(a)(4):

MS PCT
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

on October 12, 2021 .
Date

/Tiffany D. Kelly/
Signature

Tiffany D. Kelly
Typed or printed name of person signing Certificate

Registration Number, if applicable

206-420-6052
Telephone Number

Note: Each paper must have its own certificate of mailing, or this certificate must identify each submitted paper.

Description (11 sheets)
Claims (4 sheets)
Abstract (1 sheet)
Drawings (2 sheets)
PCT Request and Fee Calculation (5 pages)
General POA (1 page)
Transmittal Letter to the United States Receiving Office (2 pages)

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

For receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (25 characters maximum)*
CCLL-11-002.0

Box No. I TITLE OF INVENTION

METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROUS ACID SOLUTION

Box No. II APPLICANT ☐ This person is also inventor

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*
COUGAR CREEK TECHNOLOGIES, LLC
12511 131ST CT NE # A-222
Kirkland, WA 98034
United States of America

Telephone No.

Facsimile No.

Applicant's registration No. with the Office

E-mail authorization: Marking one of the check-boxes below authorizes the receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority to use the e-mail address indicated in this Box to send notifications issued in respect of this international application to that e-mail address if those offices are willing to do so.
☐ as advance copies followed by paper notifications; or ☐ exclusively in electronic form (no paper notifications will be sent).
E-mail address:

State *(that is, country)* of nationality:
US

State *(that is, country)* of residence:
US

This person is applicant for the purposes of: ☒ all designated States ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*
BLACK, Bruce E.
Branch Partners PLLC
600 University Street, Suite 620
Seattle, WA 98101
United States of America

Telephone No.
206-420-6050

Facsimile No.
206-420-6051

Agent's registration No. with the Office
41,622

E-mail authorization: Marking one of the check-boxes below authorizes the receiving Office, the International Searching Authority, the International Bureau and the International Preliminary Examining Authority to use the e-mail address indicated in this Box to send notifications issued in respect of this international application to that e-mail address if those offices are willing to do so.
☐ as advance copies followed by paper notifications; or ☒ exclusively in electronic form (no paper notifications will be sent).
E-mail address: patentdocketing@branchpartners.law

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet should not be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*	This person is:
LI, Liyu 7129 169th Ave SE Bellevue, WA 98006 United States of America	☐ applicant only ☐ applicant and inventor ☒ inventor only *(If this check-box is marked, do not fill in below.)*
	Applicant's registration No. with the Office
State *(that is, country)* of nationality:	State *(that is, country)* of residence:
This person is applicant for the purposes of: ☐ all designated States	☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*	This person is:
	☐ applicant only ☐ applicant and inventor ☐ inventor only *(If this check-box is marked, do not fill in below.)*
	Applicant's registration No. with the Office
State *(that is, country)* of nationality:	State *(that is, country)* of residence:
This person is applicant for the purposes of: ☐ all designated States	☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*	This person is:
	☐ applicant only ☐ applicant and inventor ☐ inventor only *(If this check-box is marked, do not fill in below.)*
	Applicant's registration No. with the Office
State *(that is, country)* of nationality:	State *(that is, country)* of residence:
This person is applicant for the purposes of: ☐ all designated States	☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*	This person is:
	☐ applicant only ☐ applicant and inventor ☐ inventor only *(If this check-box is marked, do not fill in below.)*
	Applicant's registration No. with the Office
State *(that is, country)* of nationality:	State *(that is, country)* of residence:
This person is applicant for the purposes of: ☐ all designated States	☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

Box No. V DESIGNATIONS

The filing of this request **constitutes under Rule 4.9(a) the designation** of all Contracting States bound by the PCT on the international filing date, for the grant of every kind of protection available and, where applicable, for the grant of both regional and national patents.

However,

☐ DE Germany **is not designated** for any kind of national protection

☐ JP Japan **is not designated** for any kind of national protection

☐ KR Republic of Korea **is not designated** for any kind of national protection

(The check-boxes above may only be used to exclude (irrevocably) the designations concerned if, at the time of filing or subsequently under Rule 26bis.1, the international application contains in Box No. VI a priority claim to an earlier national application filed in the particular State concerned, in order to avoid the ceasing of the effect, under the national law, of this earlier national application.)

Box No. VI PRIORITY CLAIM AND DOCUMENT

The priority of the following earlier application(s) is hereby claimed:

Filing date of earlier application *(day/month/year)*	Number of earlier application	Where earlier application is:		
		national application: country or Member of WTO	regional application: regional Office	international application: receiving Office
item (1) 04 November 2020 (04/11/2020)	17/089,537	US		
item (2)				
item (3)				

☐ Further priority claims are indicated in the Supplemental Box.

Furnishing the priority document(s):

☒ The **receiving Office** is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application(s) was filed with the receiving Office which, for the purposes of this international application, is the receiving Office)* identified above as:

☒ all items ☐ item (1) ☐ item (2) ☐ item (3) ☐ other, see Supplemental Box

☐ The **International Bureau** is requested to obtain from a digital library a certified copy of the earlier application(s) identified above, using, where applicable, the access code(s) indicated below *(if the earlier application(s) is available to it from a digital library)*:

☐ item (1) access code _____ ☐ item (2) access code _____ ☐ item (3) access code _____ ☐ other, see Supplemental Box

Restore the right of priority: the receiving Office is requested to restore the right of priority for the earlier application(s) identified above or in the Supplemental Box as item(s) (_____). *(See also the Notes to Box No. VI; further information **must** be provided to support a request to restore the right of priority.)*

Incorporation by reference: where an element of the international application referred to in Article 11(1)(iii)(d) or (e) or a part of the description, claims or drawings referred to in Rule 20.5(a), or an element or part of the description, claims or drawings referred to in Rule 20.5*bis*(a) is not otherwise contained in this international application but is completely contained in an earlier application whose priority is claimed on the date on which one or more elements referred to in Article 11(1)(iii) were first received by the receiving Office, that element or part is, subject to confirmation under Rule 20.6, incorporated by reference in this international application for the purposes of Rule 20.6.

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if more than one International Searching Authority is competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used)*:

ISA/ US

Box No. IX CHECK LIST for EFS-Web filings - this sheet is only to be used when filing an international application with RO/US via **EFS-Web**

This international application **contains** the following:	Number of sheets
(a) request form PCT/RO/101 (including any declarations and supplemental sheets)	4
(b) description (excluding any sequence listing part of the description, see (f), below)	11
(c) claims	4
(d) abstract	1
(e) drawings (if any)	2
(f) sequence listing part of the description in the form of an **image file** (e.g. PDF)	
Total number of sheets (including the sequence listing part of the description if **filed as an image file**)	22

(g) sequence listing part of the description

- ☐ filed in the form of an **Annex C/ST.25 text file**
- ☐ WILL BE filed separately on physical data carrier(s), on the same day and in the form of an **Annex C/ST.25 text file**

Indicate type and number of physical data carrier(s):

This international application is **accompanied by** the following item(s) *(mark the applicable check-boxes below and indicate in right column the number of each item)*:	Number of items
1. ☒ fee calculation sheet	1
2. ☐ original separate power of attorney	
3. ☐ original general power of attorney	
4. ☒ copy of general power of attorney; reference number:	1
5. ☐ priority document(s) identified in Box No. VI as item(s)	
6. ☐ Translation of international application into *(language)*:	
7. ☐ separate indications concerning deposited microorganism or other biological material	
8. ☐ *(only where item (f) is marked in the left column)* copy of the sequence listing in electronic form (Annex C/ST.25 text file) not forming part of the international application but **furnished only for the purposes of international search** under Rule 13*ter*	
9. ☐ *(only where item (f) (in the left column) and item 8 (above) are marked)* a statement confirming that "the information recorded in electronic form submitted under Rule 13*ter* is identical to the sequence listing as contained in the international application" as filed via EFS-Web:	
10. ☐ copy of results of earlier search(es) (Rule 12*bis*.1(a))	
11. ☒ other *(specify)*: PCT Trans.; Cert. of Electronic Filing	2

Figure of the drawings which should accompany the abstract:	1	**Language of filing** of the international application:	English

Box No. X SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

/Bruce E. Black/

Bruce E. Black, Agent for Applicant(s), Reg. No. 41,622
Branch Partners PLLC

For receiving Office use only

1. Date of actual receipt of the purported international application:	2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:	
4. Date of timely receipt of the required corrections under PCT Article 11(2):	
5. International Searching Authority (if two or more are competent):	6. ☐ Transmittal of search copy delayed until search fee is paid

For International Bureau use only

Date of receipt of the record copy by the International Bureau:

This sheet is not part of and does not count as a sheet of the international application.

PCT

FEE CALCULATION SHEET

Annex to the Request

For receiving Office use only

International Application No.

Date stamp of the receiving Office

Applicant's or agent's file reference: CCLL-11-002.0

Applicant: COUGAR CREEK TECHNOLOGIES, LLC

CALCULATION OF PRESCRIBED FEES

(Applicants may be entitled to a reduction of certain fees as indicated in the PCT Fee Tables (www.wipo.int/pct/en/fees.pdf))

1. TRANSMITTAL FEE	130.00 T	
2. SEARCH FEE	1,090.00 S	

International search to be carried out by: US

3. INTERNATIONAL FILING FEE

Enter total number of sheets indicated in Box No IX: 22

i1 Fixed amount for the first 30 sheets	1,344.00 i1	
i2 _____ (number of sheets in excess of 30) x _____ (fee per sheet) =	0 i2	
Add amounts entered at i1 and i2 and enter total at I	1,344.00 I	

(Applicants from certain States are entitled to a reduction of 90% of the international filing fee (see www.wipo.int/pct/en/fees/fee_reduction.pdf). Where the applicant is (or all applicants are) so entitled, the total to be entered at I is 10% of the international filing fee.)

4. FEE FOR PRIORITY DOCUMENT *(if applicable)*	P	
5. FEE FOR RESTORATION OF THE RIGHT OF PRIORITY *(if applicable)*	RP	
6. FEE FOR EARLIER SEARCH DOCUMENTS *(if applicable)*	ES	
7. TOTAL FEES PAYABLE: Add amounts entered at T, S, I, P, RP and ES, and enter total in the TOTAL box	2,564.00 TOTAL	

MODE OF PAYMENT *(Not all modes of payment may be available at all receiving Offices)*

- ☒ credit card *(details should not be included on this sheet)*
- ☐ authorization to charge deposit or current account (see below)
- ☐ bank transfer
- ☐ cash
- ☐ postal money order
- ☐ check
- ☐ revenue stamps
- ☐ other *(specify)*:

AUTHORIZATION TO CHARGE (OR CREDIT) DEPOSIT OR CURRENT ACCOUNT

(This mode of payment may not be available at all receiving Offices)

Receiving Office: RO/ US

- ☐ Authorization to charge the total fees indicated above.
- ☒ *(This check-box may be marked only if the conditions for deposit or current accounts of the receiving Office so permit)* Authorization to charge any deficiency or credit any overpayment in the total fees indicated above.
- ☐ Authorization to charge the fee for priority document.

Deposit or Current Account No.: 60-3581

Date: October 12, 2021

Name: Bruce E. Black

Signature: /Bruce E. Black/