PTO/AIA/15 (10-17)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	CCLL-1-002.0
First Named Inventor	Liyu Li
Title	METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROU
Priority Mail Express® Label No.	VIA EFS

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. [✔] **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. [✔] **Applicant asserts small entity status.** See 37 CFR 1.27
3. [ ] **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. [✔] **Specification** [*Total Pages* 17] Both the claims and abstract must start on a new page. *(See MPEP § 608.01(a) for information on the preferred arrangement)*
5. [✔] **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* 2]
6. **Inventor's Oath or Declaration** [*Total Pages* 2] *(including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))*
   a. [✔] Newly executed (original or copy)
   b. [ ] A copy from a prior application (37 CFR 1.63(d))
7. [✔] **Application Data Sheet** ** See note below.* See 37 CFR 1.76 (PTO/AIA/14 or equivalent)
8. **CD-ROM or CD-R** in duplicate, large table, or Computer Program (*Appendix*)
   [ ] Landscape Table on CD
9. **Nucleotide and/or Amino Acid Sequence Submission** (*if applicable, items a. – c. are required*)
   a. [ ] Computer Readable Form (CRF)
   b. [ ] Specification Sequence Listing on:
      i. [ ] CD-ROM or CD-R (2 copies); or
      ii. [ ] Paper
   c. [ ] Statements verifying identity of above copies

ADDRESS TO:

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

ACCOMPANYING APPLICATION PAPERS

10. [ ] **Assignment Papers** (cover sheet & document(s))
    Name of Assignee _____
11. [ ] **37 CFR 3.73(c) Statement** (*when there is an assignee*) [ ] **Power of Attorney**
12. [ ] **English Translation Document** (*if applicable*)
13. [ ] **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
    [ ] Copies of citations attached
14. [ ] **Preliminary Amendment**
15. [ ] **Return Receipt Postcard** (*MPEP § 503*) (*Should be specifically itemized*)
16. [ ] **Certified Copy of Priority Document(s)** (*if foreign priority is claimed*)
17. [ ] **Nonpublication Request** Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
18. [✔] **Other:** Certificate of Electronic Filing; Certification and Request for Prioritized Examination

*Note: (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must** be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

19. CORRESPONDENCE ADDRESS

[✔] The address associated with Customer Number: 122997 **OR** [ ] Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone		Email	

Signature	/Bruce E. Black/	Date	November 4, 2020
Name (Print/Type)	Bruce E. Black	Registration No. (Attorney/Agent)	41,622

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.

PTO/SB/17 (10-20)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

FEE TRANSMITTAL

Complete if known	
Application Number	Not Yet Assigned
Filing Date	November 4, 2020
First Named Inventor	Liyu Li
Examiner Name	Not Yet Assigned
Art Unit	Not Yet Assigned
Practitioner Docket No.	CCLL-1-002.0

☐ Applicant asserts small entity status. See 37 CFR 1.27.

☐ Applicant certifies micro entity status. See 37 CFR 1.29. Form PTO/SB/15A or B or equivalent must either be enclosed or have been submitted previously.

TOTAL AMOUNT OF PAYMENT ($) 3,100.00

METHOD OF PAYMENT (check all that apply)

☐ Check ■ Credit Card ☐ Money Order ☐ None ☐ Other (please identify): _____

■ Deposit Account Deposit Account Number: 50-1050 Deposit Account Name: Lowe Graham Jones PLLC

For the above-identified deposit account, the Director is hereby authorized to (check all that apply):

☐ Charge fee(s) indicated below ☐ Charge fee(s) indicated below, **except for the filing fee**

■ Charge any additional fee(s) or underpayment of fee(s) under 37 CFR 1.16 and 1.17 ■ Credit any overpayment of fee(s)

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

FEE CALCULATION

1. BASIC FILING, SEARCH, AND EXAMINATION FEES (U = undiscounted fee; S = small entity fee; M = micro entity fee)

	FILING FEES			SEARCH FEES			EXAMINATION FEES			
Application Type	**U ($)**	**S ($)**	**M ($)**	**U ($)**	**S ($)**	**M ($)**	**U ($)**	**S ($)**	**M ($)**	**Fees Paid ($)**
Utility	320	160*	80	700	350	175	800	400	200	830.00
Design	220	110	55	160	80	40	640	320	160	
Plant	220	110	55	440	220	110	660	330	165	
Reissue	320	160	80	700	350	175	2,320	1,160	580	
Provisional	300	150	75	0	0	0	0	0	0	

* The $160 small entity status filing fee for a utility application is further reduced to $80 for a small entity status applicant who files the application via EFS-Web.

2. EXCESS CLAIM FEES

Fee Description	**Undiscounted Fee ($)**	**Small Entity Fee ($)**	**Micro Entity Fee ($)**
Each claim over 20 (including Reissues)	100	50	25
Each independent claim over 3 (including Reissues)	480	240	120
Multiple dependent claims	860	430	215

Total Claims		**Extra Claims**	**Fee ($)**		**Fee Paid ($)**
22	-20 or HP =	2 x	50.00	=	100.00

HP = highest number of total claims paid for, if greater than 20.

Indep. Claims		**Extra Claims**	**Fee ($)**		**Fee Paid ($)**
2	-3 or HP =	_____ x	_____	=	_____

HP = highest number of independent claims paid for, if greater than 3.

Multiple Dependent Claims	**Fee ($)**	**Fee Paid ($)**
	_____	_____

3. APPLICATION SIZE FEE

If the specification and drawings exceed 100 sheets of paper (excluding electronically filed sequence or computer listings under 37 CFR 1.52(e)), the application size fee due is $420 ($210 for small entity) ($105 for micro entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).

Total Sheets		**Extra Sheets**		**Number of each additional 50 or fraction thereof**		**Fee ($)**		**Fee Paid ($)**
19	- 100 =	_____	/ 50 =	_____ (round **up** to a whole number)	x	_____	=	_____

4. OTHER FEE(S) **Fees Paid ($)**

Non-English specification, $140 fee ($70 for small entity) ($35 for micro entity) _____

Non-electronic filing fee under 37 CFR 1.16(t) for a utility application, $400 fee ($200 small or micro entity) _____

Other (e.g., late filing surcharge): Request for prioritized examination; Processing Fee 2,170.00

SUBMITTED BY

Signature	/Bruce E. Black/	Registration No. (Attorney/Agent) 41,622	Telephone 206-957-2167
Name (Print/Type)	Bruce E. Black		Date November 4, 2020

Doc Code: TRACK1.REQ
Document Description: TrackOne Request

PTO/AIA/424 (04-14)

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e) (Page 1 of 1)

First Named Inventor:	Liyu Li	Nonprovisional Application Number (if known):	Not Yet Assigned
Title of Invention:	METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROUS ACID SOLUTION		

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently $0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.

2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.

3. The applicable box is checked below:

I. ☑ Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)

i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.

---OR---

(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.

ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, **or** the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

II. ☐ Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)

i. A request for continued examination has been filed with, or prior to, this form.
ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature /Bruce E. Black/	Date November 4, 2020
Name (Print/Typed) Bruce E. Black	Practitioner Registration Number 41622

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.**

☑ *Total of 1 forms are submitted.

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.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CCLL-1-002.0
	Application Number	
Title of Invention	METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROUS ACID SOLUTION	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 — Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Liyu		Li	

Residence Information (Select One) ● US Residency Non US Residency Active US Military Service

City	Bellevue	State/Province	WA	Country of Residence	US

Mailing Address of Inventor:

Address 1	7129 169th Ave SE
Address 2	

City	Bellevue	State/Province	WA
Postal Code	98006	**Country**	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. — Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	122997		
Email Address	patentdocketing@lowegrahamjones.com	Add Email	Remove Email

Application Information:

Title of the Invention	METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROUS ACID SOLUTION		
Attorney Docket Number	CCLL-1-002.0	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	2	**Suggested Figure for Publication (if any)**	

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CCLL-1-002.0
	Application Number	
Title of Invention	METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROUS ACID SOLUTION	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	● Customer Number	US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	122997		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CCLL-1-002.0
	Application Number	
Title of Invention	METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROUS ACID SOLUTION	

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CCLL-1-002.0
	Application Number	
Title of Invention	METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROUS ACID SOLUTION	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CCLL-1-002.0
	Application Number	
Title of Invention	METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROUS ACID SOLUTION	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 — Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Applicant:

Address 1			
Address 2			
City		**State/Province**	
Country		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CCLL-1-002.0
	Application Number	
Title of Invention	METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROUS ACID SOLUTION	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Bruce E. Black/			Date (YYYY-MM-DD)	2020-11-04
First Name	Bruce E.	Last Name	Black	Registration Number	41622

Additional Signature may be generated within this form by selecting the Add button. Add

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	CCLL-1-002.0
	Application Number	
Title of Invention	METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROUS ACID SOLUTION	

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: 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 the Freedom of Information Act requires disclosure of these records.

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 CooperationTreaty.

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 inspections 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.

PTO/AIA/01 (06-12)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROUS ACID SOLUTION

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [■] The attached application, or
- [ ] United States application or PCT international application number _____ filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

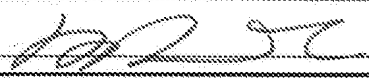
I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Liyu Li Date (Optional): 1-4-2020

Signature: 

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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.

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.

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.

METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROUS ACID SOLUTION

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.

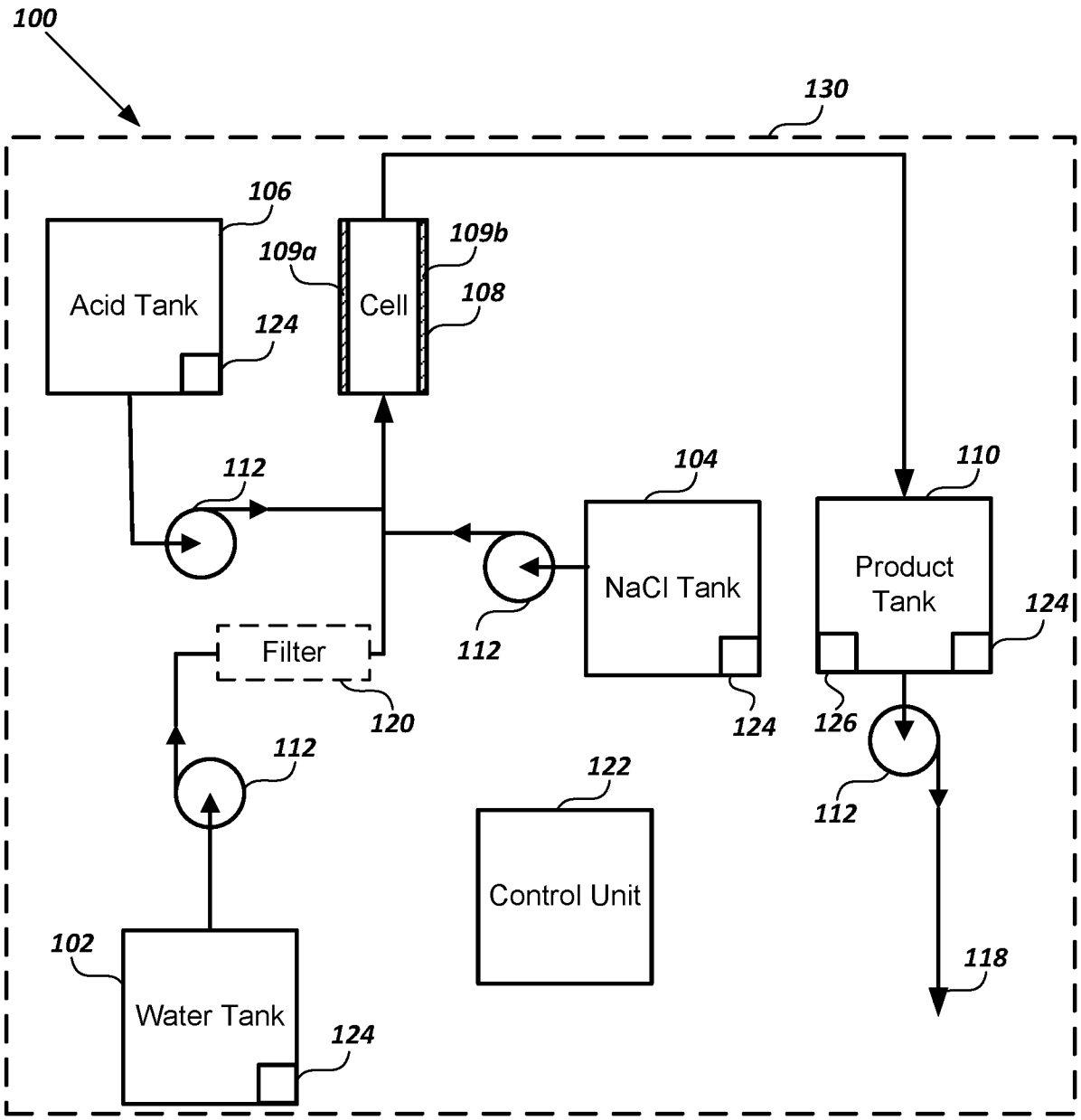

100
130
106
109a
109b
108
Acid Tank
Cell
124
112
104
110
NaCl Tank
Product Tank
124
Filter
120
112
124
126
112
122
Control Unit
112
102
Water Tank
124
118

Fig. 1

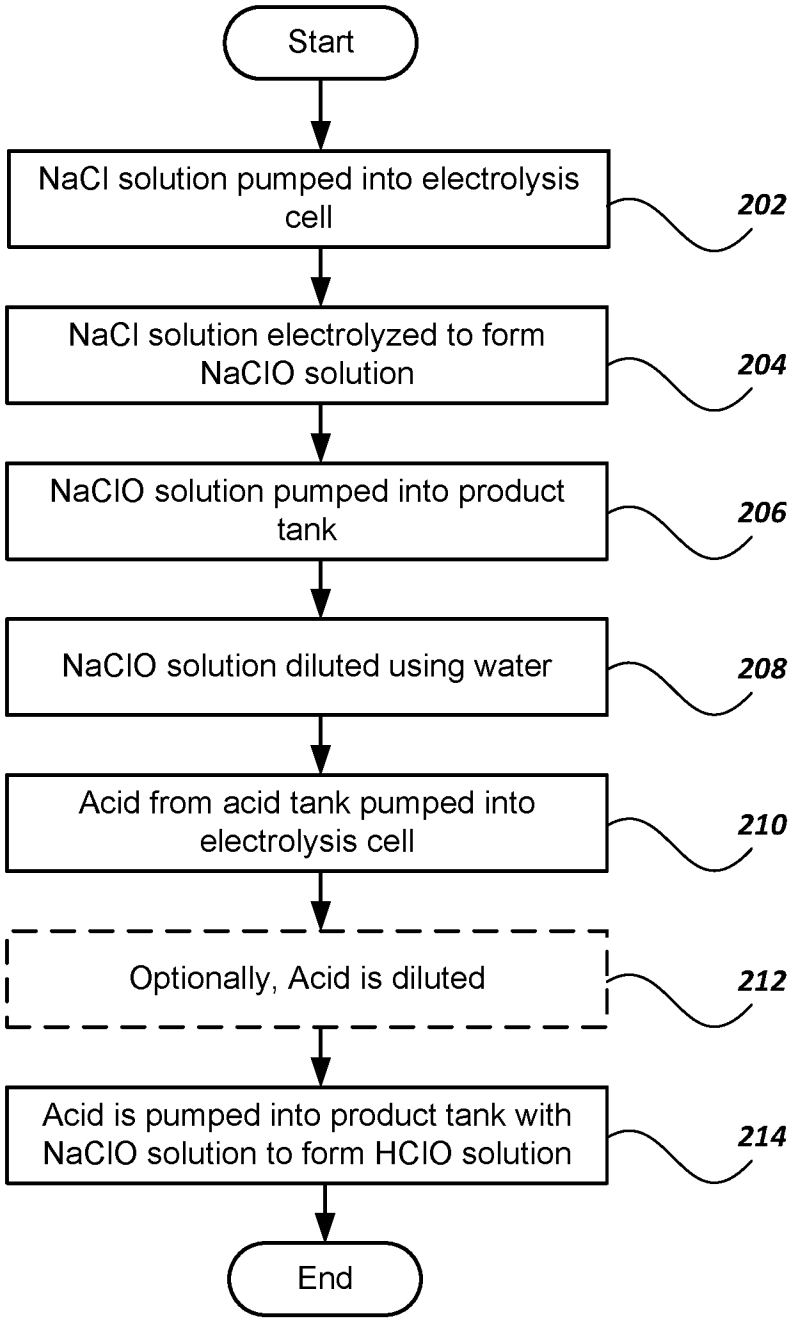

Start
NaCl solution pumped into electrolysis cell
202
NaCl solution electrolyzed to form NaClO solution
204
NaClO solution pumped into product tank
206
NaClO solution diluted using water
208
Acid from acid tank pumped into electrolysis cell
210
Optionally, Acid is diluted
212
Acid is pumped into product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

Fig. 2

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:	Liyu Li
Filer:	Bruce Black/Tiffany Kelly
Attorney Docket Number:	CCLL-1-002.0

Filed as Small Entity

Filing Fees for Track I Prioritized Examination - Nonprovisional Application under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY FILING FEE (ELECTRONIC FILING)	4011	1	80	80
UTILITY SEARCH FEE	2111	1	350	350
UTILITY EXAMINATION FEE	2311	1	400	400
REQUEST FOR PRIORITIZED EXAMINATION	2817	1	2100	2100
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	2202	2	50	100
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
PUBL. FEE- EARLY, VOLUNTARY, OR NORMAL	1504	1	0	0
PROCESSING FEE, EXCEPT PROV. APPLS.	2830	1	70	70

Petition:	
Patent-Appeals-and-Interference:	
Post-Allowance-and-Post-Issuance:	
Extension-of-Time:	
Miscellaneous:	
Total in USD ($)	**3100**

Electronic Acknowledgement Receipt

EFS ID:	41038699
Application Number:	17089537
International Application Number:	
Confirmation Number:	1042
Title of Invention:	METHODS AND SYSTEMS FOR PRODUCTION OF AN AQUEOUS HYPOCHLOROUS ACID SOLUTION
First Named Inventor/Applicant Name:	Liyu Li
Customer Number:	122997
Filer:	Bruce Black/Tiffany Kelly
Filer Authorized By:	Bruce Black
Attorney Docket Number:	CCLL-1-002.0
Receipt Date:	04-NOV-2020
Filing Date:	
Time Stamp:	18:38:16
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$3100
RAM confirmation Number	E2020A4I38404250
Deposit Account	501050
Authorized User	Tiffany Kelly

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

37 CFR 1.16 (National application filing, search, and examination fees)

37 CFR 1.17 (Patent application and reexamination processing fees)

37 CFR 1.19 (Document supply fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Miscellaneous Incoming Letter	CCLL-1-002Cert.pdf	93196 096dceaaa3ff3ea2157934224346bb9cbc77dc06	no	1
Warnings:					
Information:					
2	Transmittal of New Application	CCLL-1-002AppTrans.pdf	386349 d263f33d0968be40d978f9e4500de1237af39f88	no	2
Warnings:					
Information:					
3	Transmittal Letter	CCLL-1-002FeeTransmittal.pdf	215769 4063fa53ac960c09dd7dff81340039a1bcf97bef	no	1
Warnings:					
Information:					
4	TrackOne Request	CCLL-1-002Track1.pdf	131557 6568f5931bb5b729b1a21357c6cd63c827c69f46	no	2
Warnings:					
Information:					
5	Application Data Sheet	CCLL-1-002ADS.pdf	1822175 d7d52ce0f738b0dcf8aef5718b04d4651de65619	no	8
Warnings:					
Information:					
6	Oath or Declaration filed	CCLL-1-002SignedDec.pdf	1361629 6fdb9c2adff717d4e6c0fb46182029526dd43568	no	2
Warnings:					
Information:					

7		CCL_002_APP_EFS.pdf	126554 08a6575b3e13412e611df9138b00b281aeda85e6	yes	17

Multipart Description/PDF files in .zip description		
Document Description	**Start**	**End**
Abstract	17	17
Claims	13	16
Specification	1	12

Warnings:

Information:

8	Drawings-only black and white line drawings	CCLL_002_Drawings_EFS.pdf	654224 524665ee8e932043b801924a3958c332a2a30ce0	no	2

Warnings:

Information:

9	Fee Worksheet (SB06)	fee-info.pdf	41340 211f08ea417cde2e367d1459ca9cf8707c356bc7	no	2

Warnings:

Information:

Total Files Size (in bytes):	4832793

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-1-002.0

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):

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

on November 4, 2020 .
Date

/Tiffany D. Kelly/
Signature

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

Registration Number, if applicable

206.957.2467
Telephone Number

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

Utility Patent Application Transmittal (2 pages)
Fee Transmittal (1 page)
Specification (17 pages)
Drawings (2 sheets)
Declaration (2 pages)
Application Data Sheet (8 pages)
Certification and Request for Prioritized Examination (2 pages)