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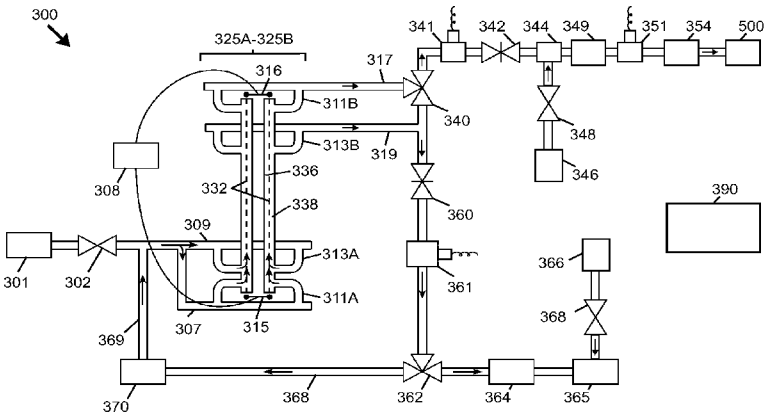

FIG._3

(57) Abstract: A stabilized mixed oxidant solution may be produced by flowing a starting solution (e.g., salt brine, hypochlorous acid, and/or sodium hypochlorite) through a flow-through electrochemical module including first and second passages separated by an ion permeable membrane while electric power is applied between an anode and cathode in electrical communication with the first and second passages, respectively. An initially acidic anolyte solution received from the first (anode) passage is stabilized by elevating pH to yield a stabilized mixed oxidant solution. Methods of using the mixed oxidant solution are further provided.

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Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

-- Please See Extra Sheet --

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-21

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.

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A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - C25B 1/14, C25B 1/22, C25B 1/26, C25B 9/18, C25B 15/08 (2014.01)
CPC - C25B 1/14, C25B 1/22, C25B 1/26, C25B 9/18, C25B 15/08
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8)- C25B 1/14, C25B 1/22, C25B 1/26, C25B 9/18, C25B 15/08 (2014.01);
CPC- C25B 1/14, C25B 1/22, C25B 1/26, C25B 9/18, C25B 15/08

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC- 204/232, 204/263, 204/253, 205/351, 205/359, 205/405, 205/406;
Patents and NPL (classification, keyword; search terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Pub West (US EP JP WO), Pat Base (AU BE BR CA CH CN DE DK EP ES FI FR GB IN JP KR SE TH TW US WO), Google Patent, Google Scholar, Free Patents Online; search terms: electrolyte, anolyte, catholyte, oxidize, oxidate, solute, aqueous, hypochlorous, acid, sodium, hypochlorite, salt, brine, disinfect, package, transport

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X -- Y	US 2010/0044242 A1 (BHAVARAJU et al.) 25 February 2010 (25.02.2010), Figs. 2, 5; para [0006]-[0011], [0014], [0035], [0038], [0039], [0050], [0054], [0055], [0076]	1-6, 12, 16-19,20/(12, 16-19), 21/(20)/(12,16-19) --- 7-11, 13-15, 20/(13-15), 21/(20)/(13-15)
Y	US 2011/0100927 A1 (VINEYARD et al.) 05 May 2011 (05.05.2011), para [0011], [0020], [0071], [0087], [0091]	7, 9-11, 13, 15, 20/(13, 15), 21/(20)/(13, 15)
Y	US 2004/0149590 A1 (FEATHERSTONE et al.) 05 August 2004 (05.08.2004), para [0053], [0064], [0077], [0091]	8, 14, 20/(14), 21/(20)/(14)
Y, P	US 8,617,403 B1 (PETERS et al.) 31 December 2013 (31.12.2013), col 3, ln 15 to col 18, ln 23	1-21
Y	WO 2012/166997 A2 (BUSCHMANN) 06 December 2012 (06.12.2012), para [0011]-[0180]	1-21
Y	US 2012/0048741 A1 (STEWART et al.) 01 March 2012 (01.03.2012), para [0012]-[0066]	1-21
Y	US 2007/0251831 A1 (KACZUR et al.) 01 November 2007 (01.11.2007), para [0007]-[0066]	1-21
Y	US 6,736,966 B2 (HERRINGTON et al.) 18 May 2004 (18.05.2004), col 2, ln 18 to col 10, ln 67	1-21

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 December 2014	02 JAN 2015
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

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Continued from Box No. III, Observations where unity of invention is lacking,

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: Claims 1-21, drawn to a method for producing a mixed oxidant solution comprising a plurality of different oxidants, the method comprising: flowing at least one starting solution through at least one flow-through electrochemical module comprising a first passage and a second passage separated by an ion permeable membrane while electric power is applied between (i) an anode in electrical communication with the first passage and (ii) a cathode in electrical communication with the second passage, wherein a first solution or first portion of the at least one starting solution is flowed through the first passage to form an anolyte solution having an acidic pH, and a second solution or second portion of the at least one starting solution is simultaneously flowed through the second passage to form a catholyte solution having a basic pH; and contacting the anolyte solution with a hydroxide solution to attain a pH value of at least about 9.0 to yield said mixed oxidant solution; wherein the at least one starting solution comprises at least one of salt brine, hypochlorous acid, and sodium hypochlorite.

Group II: Claims 22-35, drawn to a method for promoting disinfection and reduction of deposits in a water-containing system with a mixed oxidant solution comprising a plurality of different oxidants produced by flowing at least one starting solution through at least one flow-through electrochemical module comprising a first passage and a second passage separated by an ion permeable membrane while electric power is applied between (i) an anode in electrical communication with the first passage and (ii) a cathode in electrical communication with the second passage, wherein a first solution or first portion of the at least one starting solution is flowed through the first passage to form an anolyte solution having an acidic pH, and a second solution or second portion of the at least one solution is simultaneously flowed through the second passage to form a catholyte solution having a basic pH, and contacting the anolyte solution with a hydroxide solution to attain a pH value of at least 9.0 to yield said mixed oxidant solution, wherein the at least one starting solution comprises at least one of salt brine, hypochlorous acid, and sodium, hypochlorite, the method comprising:
supplying an effective amount of the mixed oxidant solution to the water-containing system.

Group III: Claims 36-54, drawn to a method for promoting disinfection and reduction of deposits in a water-containing system utilizing (a) a primary disinfectant and (b) a mixed oxidant solution comprising a plurality of different oxidants produced by flowing at least one starting solution including at least one of salt brine, hypochlorous acid, and sodium hypochlorite through at least one flow-through electrochemical module comprising a first passage and a second passage separated by an ion permeable membrane while electric power is applied between (i) an anode in electrical communication with the first passage and (ii) a cathode in electrical communication with the second passage, wherein a first solution or first portion of the at least one starting solution is flowed through the first passage to form an anolyte solution having an acidic pH, and a second solution or second portion of the at least one solution is simultaneously flowed through the second passage to form a catholyte solution having a basic pH, and contacting the anolyte solution with a hydroxide solution to attain a pH value of at least 9.0 to yield said mixed oxidant solution, the method comprising one of the following steps (A) or (B):
(A) blending the primary disinfectant and the mixed oxidant solution, and supplying an effective amount of primary disinfectant and mixed oxidant solution to the water-containing system; or
(B) co-injecting the primary disinfectant and the mixed oxidant solution, and supplying an effective amount of primary disinfectant and mixed oxidant solution to the water-containing system.

The groups of inventions listed above do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Special Technical Features

The inventions listed as Groups I through III do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

Groups II and III do not require a method for producing a mixed oxidant solution (product), as required by Group I.

Groups I and III do not require a method for promoting disinfection and reduction of deposits in a water-containing system with a mixed oxidant solution (intermediary) by supplying an effective amount of the mixed oxidant solution to the water-containing system, as required by Group II.

Group I and II do not require a method for promoting disinfection and reduction of deposits in a water-containing system utilizing (a) a primary disinfectant and (b) a mixed oxidant solution, the method further comprising one of the following steps (A) or (B): (A) blending the primary disinfectant and the mixed oxidant solution, and supplying an effective amount of primary disinfectant and mixed oxidant solution to the water-containing system; or (B) co-injecting the primary disinfectant and the mixed oxidant solution, and supplying an effective amount of primary disinfectant and mixed oxidant solution to the water-containing system, as required by Group III.

Shared Common Features

The only feature shared by Groups I through III that would otherwise unify the groups is a method comprising:
flowing at least one starting solution through at least one flow-through electrochemical module comprising a first passage and a second passage separated by an ion permeable membrane while electric power is applied between (i) an anode in electrical communication with the first passage and (ii) a cathode in electrical communication with the second passage, wherein a first solution or first portion of the at least one starting solution is flowed through the first passage to form an anolyte solution having an acidic pH, and a second solution or second portion of the at least one starting solution is simultaneously flowed through the second passage to form a catholyte solution having a basic pH; and contacting the anolyte solution with a hydroxide solution to attain a pH value of at least about 9.0 to yield said mixed oxidant solution; wherein the at least one starting solution comprises at least one of salt brine, hypochlorous acid, and sodium hypochlorite.

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Continued from Box No. III, Observations where unity of invention is lacking,

However, this shared technical feature does not represent a contribution over prior art, because the shared technical feature is anticipated by US 2010/00044242 A1 to Bhavaraju, et al. (hereinafter 'Bhavaraju'). Bhavaraju discloses a method (para [0006], [0008]), the method comprising: flowing at least one starting solution through at least one flow-through electrochemical module comprising a first passage and a second passage separated by an ion permeable membrane while electric power is applied between (i) an anode in electrical communication with the first passage and (ii) a cathode in electrical communication with the second passage (Fig. 2; para [0035], [0038], [0039], [0050], anolyte compartment, 102, middle compartment, 104, and catholyte compartment, 106... anionic membrane, 112, cation-conductive membrane, 114, and power supply, 116), wherein a first solution or first portion of the at least one starting solution is flowed through the first passage to form an anolyte solution having an acidic pH, and a second solution or second portion of the at least one starting solution is simultaneously flowed through the second passage to form a catholyte solution having a basic pH (Fig. 2; para [0010], [0011], [0050], acidic pH at anode, 102, comprising feed stream (first solution), 10 and 10a... and second feed stream (second solution), 12, to cathode, 106... wherein catholyte has pH of between about 7 and 14.); and contacting the anolyte solution with a hydroxide solution to attain a pH value of at least about 9.0 to yield said mixed oxidant solution (Fig. 2; para [0009], [0011], [0050], sodium hydroxide added to middle compartment, 104... having pH between about 6 and 14... split from anolyte solution, 10b, and further comprising sodium hydroxide.); wherein the at least one starting solution comprises at least one of salt brine (para [0009], [0050]), hypochlorous acid (para [0006], [0014]), and sodium hypochlorite (para [0006], [0008]).

However, Bhavaraju discloses a method for promoting disinfection (para [0003], [0005], [0006]) and reduction of deposits in a water-containing system (para [0071], [0078]).

As the technical feature was known in the art at the time of the invention, this cannot be considered a special technical feature that would otherwise unify the groups.

Groups I through III therefore lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.