



(51) International Patent Classification:

B01J 27/053 (2006.01) C07C 407/00 (2006.01)  
B01J 31/02 (2006.01)

(21) International Application Number:

PCT/US2019/024516

(22) International Filing Date:

28 March 2019 (28.03.2019)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/649,988 29 March 2018 (29.03.2018) US

(71) Applicant: **SAFE FOODS CORPORATION** [US/US];  
4801 North Shore Drive, North Little Rock, Arkansas 72118  
(US).

(72) Inventors: **COLEMAN, Todd**; 4801 North Shore Drive,  
North Little Rock, Arkansas 72118 (US). **YEAMAN, Tim**;  
4801 North Shore Drive, North Little Rock, Arkansas 72118  
(US). **FRY, Slaton**; 4801 North Shore Drive, North Little  
Rock, Arkansas 72118 (US).

(74) Agent: **TOBIN, Michael J.** et al.; Haynes and Boone, LLP,  
2323 Victory Avenue, Ste. 700, Dallas, Texas 75219 (US).

(81) Designated States (unless otherwise indicated, for every  
kind of national protection available): AE, AG, AL, AM,  
AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ,  
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO,  
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,  
HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP,  
KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME,  
MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ,  
OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,  
SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN,  
TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every  
kind of regional protection available): ARIPO (BW, GH,  
GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ,  
UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ,  
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,  
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV,  
MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM,

(54) Title: ONLINE PRODUCTION OF ORGANIC PEROXIDE USING A CATALYST BED

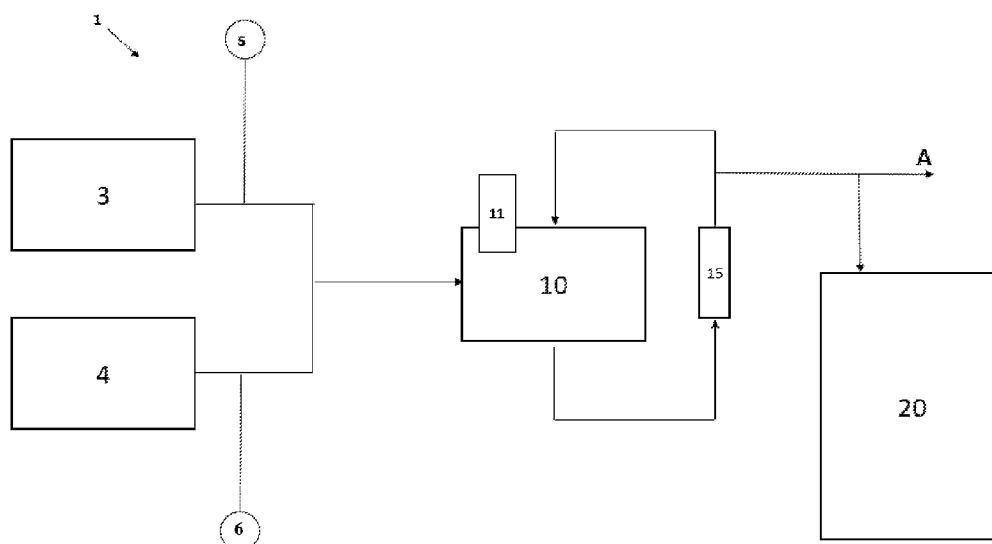


FIG. 1

(57) Abstract: A method of producing an organic peroxide includes introducing an organic solution and a peroxide solution into a mixing tank to form a mixture. The method further includes circulating the mixture over a fixed catalyst bed to form the organic peroxide and measuring a concentration of the organic peroxide in the mixture. Further, the method includes removing at least a portion of the mixture when the concentration reaches a set value.

TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW,  
KM, ML, MR, NE, SN, TD, TG).

**Published:**

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the  
claims and to be republished in the event of receipt of  
amendments (Rule 48.2(h))*

## ONLINE PRODUCTION OF ORGANIC PEROXIDE USING A CATALYST BED

### I. Cross-reference to Related Applications

The present application claims benefit of U.S. Provisional Patent Application No. 62/649,988  
5 filed March 29, 2018, titled "Online Production of Peroxyacetic Acid Using a Catalyst Bed," which is  
incorporated herein by reference in its entirety.

### II. Technical Field

The present description relates to a method and system for producing organic peroxides.

### III. Background

Organic peroxides have a variety of uses. For instance, peroxyacetic acid (PAA) is a  
commonly used antimicrobial agent in the food industry and, in particular, in the poultry, pork, and  
beef processing industries. While PAA has been shown to be a very effective antimicrobial agent, its  
15 use has several drawbacks. Namely, PAA solutions are unstable under normal storage conditions and  
can lose potency over a relatively short time period. Additionally, PAA vapors represent a health risk  
to plant and federal inspection employees, and handling relatively concentrated solutions of PAA  
represents a potential exposure hazard to employees in processing plants. Moreover, transporting  
concentrated solutions of PAA on public transportation routes presents a potential exposure hazard to  
20 the general population.

### IV. Summary of the Disclosure

Exemplary embodiments of the present disclosure relate to a method of producing an organic  
peroxide, in particular, PAA, online using a controlled mixing system that allows the simultaneous  
25 and precise control of the addition of a solution of hydrogen peroxide and a solution of an organic  
compound, such as acetic acid, to a mixing tank to provide the desired concentration of an organic  
peroxide (PAA) for direct application to poultry and beef carcasses. The present disclosure is also  
directed to a system for online production of an organic peroxide, such as PAA. The system  
eliminates the need to manufacture concentrated organic peroxide solutions and the need to transport  
30 these solutions to processing plants for subsequent dilution and application.

## V. Brief Description of the Drawings

Non-limiting and non-exhaustive embodiments of the present embodiments are described with reference to the following figure. It will be appreciated that elements in the figure are illustrated for simplicity and clarity and have not necessarily been drawn to scale.

5 FIG. 1 is a schematic showing an embodiment of the present disclosure.

## VI. Detailed Description

While the present disclosure is described herein with reference to illustrative embodiments for particular applications, it should be understood that the disclosure is not limited thereto. Other  
10 embodiments are possible, and modifications can be made to the embodiments within the spirit and scope of the teachings herein and additional fields in which the embodiments would be of significant utility.

Referring to FIG. 1, the online production system 1 includes organic supply 3 and peroxide supply 4. The organic supply 3 provides an organic compound to be oxidized. Nonlimiting examples  
15 of suitable organic compounds include organic acids with 1 to 8 carbon atoms, such as acetic acid, citric acid, lactic acid, and dicarboxylic acids having 2 to 8 carbon atoms. The peroxide supply 4 provides a peroxide, such as hydrogen peroxide, which is capable of oxidizing the organic compound. Each of supplies 3 and 4 are in fluid communication with mix tank 10.

Organic supply 3 may be in fluid communication with a water supply 5. Flow rates from  
20 organic supply 3 and water supply 5, respectively, may be independently adjusted accordingly to provide a desired concentration of the organic compound within an organic solution to be supplied to mix tank 10. For instance, the organic solution may include 10-50 wt% of the organic compound, e.g., 15-40 wt%, 15-35 wt%, 15-30 wt%, 20-35 wt%, 20-30 wt%, 10 wt%, 15 wt%, 20 wt%, 25 wt%, 30 wt%, 35 wt%, or 40 wt%. In some embodiments, the organic solution is diluted to the desired  
25 concentration before entering the system 1. In some embodiments, water may be supplied directly to the mix tank 10 rather than being mixed with the organic compound first.

Peroxide supply 4 may be in fluid communication with a water supply 6. Flow rates from  
peroxide supply 4 and water supply 6, respectively, may be independently adjusted accordingly to provide a desired concentration of the peroxide within a peroxide solution to be supplied to mix tank  
30 10. For instance, the peroxide solution may include 10-50 wt% of the peroxide, e.g., 10-30 wt%, 10-20 wt%, 15-40 wt%, 15-35 wt%, 15-30 wt%, 20-35 wt%, 20-30 wt%, 5 wt%, 10 wt%, 15 wt%, 20 wt%, 25 wt%, 30 wt%, 35 wt%, or 40 wt%. In some embodiments, the peroxide solution is diluted to the desired concentration before entering the system 1. In some embodiments, water may be supplied directly to the mix tank 10 rather than being mixed with the peroxide first.

The order of adding the organic solution and the peroxide solution into the mix tank 10 is not particularly limited. In some embodiments, the organic solution may be added first, the peroxide solution may be added first, the organic solution and the peroxide solution may be added simultaneously, or the organic solution and the peroxide solution may be alternately added to the mix tank 10. In any embodiment, the organic solution and the peroxide solution may be added to the mix tank 10 through a single line as shown in FIG. 1 or through separate lines (not shown).

In some embodiments, a first solution (either the organic solution or the peroxide solution) is provided to the mix tank 10 until the mix tank 10 reaches a first specified capacity, such as 10 vol%, 20 vol%, 30 vol%, 40 vol%, 50 vol%, or 60 vol%. Thereafter, the other solution is added until the mix tank 10 reaches a second specified capacity. The second specified capacity may be, e.g., 10 vol%, 20 vol%, 30 vol%, 40 vol%, 50 vol%, or 60 vol% greater than the first specified capacity. In some embodiments, the organic solution and the peroxide solution are simultaneously added to the mixing tank until the capacity reaches, e.g., 60 vol%, 70 vol%, 80 vol%, 90 vol%, or 100 vol%.

Once the organic solution and peroxide solution have been added to the mix tank 10, the mixture may be circulated through a catalyst bed 15. The catalyst bed 15 includes a catalyst that facilitates the reaction between the organic compound and the peroxide to thereby form an organic peroxide. The catalyst bed 15 may include an acid resin. The acid resin is not particularly limited and may include, e.g., acid resins under the following trade names: Amberlite® IR120 Plus, Amberlyst® 15, Amberlyst® 36, Dowex® 50WX2, Dowex® 50WX4, Dowex® 50WX8, Dowex® HCR-S, Dowex® 650C, Dowex® Marathon C, Dowex® DR-2030 (each available from The Dow Chemical Company), Nafion® NR40, or Nafion® NR50 (each available from DuPont). During or before circulation, the mixture may be heated to, e.g., 30°C, 35°C, 40°C, 45°C, or 50°C.

The system 1 includes a sensor 11 to measure a conversion rate of the organic compound and the peroxide to an organic peroxide, e.g., by continuously or intermittently measuring a concentration of organic peroxide in the solution. For instance, in embodiments wherein the organic peroxide is PAA, the sensor 11 may be a PAA probe that measures the concentration of PAA in the solution. The location of the sensor 11 is not particularly limited. For example, the sensor may be inside or connected to the mix tank 10, as shown in FIG. 1. In some embodiments, more than one sensor 11 is provided, and in such embodiments, the sensors 11 may be the same or different from one another.

In some embodiments, the circulation of the mixture from the mix tank 10 to the catalyst bed 15 may be stopped after a specified period of time or once the sensor 11 detects a target concentration of the organic peroxide in the organic peroxide solution. For instance, the target concentration may be between 10 ppm and 10,000 ppm, inclusive, based on the total mass of the mixture. For instance, based on the total mass of the mixture, a target concentration may be 10 ppm, 20 ppm, 30 ppm, 40

ppm, 50 ppm, 75 ppm, 100 ppm, 125 ppm, 150 ppm, 200 ppm, 250 ppm, 300 ppm, 350 ppm, 400 ppm, 450 ppm, 500 ppm, 550, ppm, 600 ppm, 650 ppm, 700 ppm, 750 ppm, 800 ppm, 900 ppm, 1,000 ppm, 1,100 ppm, 1,200 ppm, 1,300 ppm, 1,400 ppm, 1,500 ppm, 1,600 ppm, 1,700 ppm, 1,800 ppm, 1,900 ppm, or 2,000 ppm.

5           Once the organic peroxide solution or a portion thereof within the system 1 has reached the target concentration, the organic peroxide solution may be removed from the circulation. The organic peroxide solution may be diverted as needed depending on the requirements of the operation. For instance, as shown by arrow A in FIG. 1, all or a portion of the organic peroxide solution may be directed to various application points. In embodiments where the organic peroxide solution has antimicrobial properties, such as PAA, various applications of the organic peroxide solution are described below. In some embodiments, all or a portion of the organic peroxide solution may be temporarily stored in an in-process tank 20. In any embodiment, the organic solution and peroxide solution may be continuously added to the mix tank 10, e.g., at a rate equal to the rate of the organic peroxide solution being removed.

15           In some embodiments, the present disclosure relates to a method for processing a food product, the method comprising sanitizing a food product with regard to at least one microorganism. In some embodiments, sanitizing a food product with regard to at least one microorganism may comprise contacting the food product with the organic peroxide solution described herein. In various embodiments, the microorganisms may comprise Gram-positive bacteria, Gram-negative bacteria, fungi, protozoa or a combination thereof. The Gram-negative bacteria may comprise *Salmonella*, *Campylobacter*, *Arcobacter*, *Aeromonas*, non-toxin-producing *Escherichia*, pathogenic toxin-producing *Escherichia* or a combination thereof. The Gram-positive bacteria may comprise *Staphylococcus*, *Bacillus*, *Listeria*, or a combination thereof. The fungi may comprise *Aspergillus flavus*, *Penicillium chrysogenum*, or a combination thereof. The protozoa may comprise *Entamoeba histolytica*.

25           In some embodiments, the present disclosure relates to a method of sanitizing a workpiece with regard to at least one microorganism, the method comprising contacting the workpiece with the organic peroxide solution described herein. The microorganism may, for example, be as described above. The workpiece may, for example, include food packaging, items and surfaces related to food or food processing, or items and surfaces unrelated to food or food processing.

30           In the methods of sanitizing described herein, the mode of applying organic peroxide solution is not particularly limited. Methods of application may include, but are not limited to, spraying, misting, fogging, immersing, pouring, dripping, and combinations thereof. Some methods of sanitizing relate to sanitizing food products or equipment during harvest and processing of the food

product. Throughout the harvest process, there are many opportunities for antimicrobial interventions, and determining what works most effectively at each step may differ from processor to processor. As such, the timing of applying the organic peroxide solution to the target article is not particularly limited. In some embodiments, the organic peroxide solution may be applied to a food product prior to an evisceration process so as to adhere to the food product throughout the evisceration process, as well as when coming into contact with equipment, viscera, and humans.

In embodiments wherein the target article is poultry, the organic peroxide solution may be applied in the processing facility in several different locations to include, but not be limited to, the following: during the pick operation to post-picking prior to evisceration, onto evisceration equipment during operation, online reprocessing (OLR) location, offline reprocessing (OFLR) location, pre-chill location, chillers, post-chill, on carcass frames post debone, and on various poultry parts in numerous locations in the plant. In embodiments wherein the target article is beef or pork, the organic peroxide solution may be applied in the processing facility in several different locations to include, but not be limited to, the following: hide on carcass application, equipment used during the harvest process, knife dip station, beef carcass application, sub-primal application, lean trimming application, and ground beef applications. In embodiments wherein the target article is fruit or vegetables, the organic peroxide solution may be applied in the processing facility in several different locations to include, but not be limited to, the following: all loading/unloading, all treatment pre-and post-flume, and prior and post to all cut up and smash treatment.

In embodiments where the organic peroxide solution is PAA, the stability of PAA may be affected by the ratio of components (e.g., acetic acid, hydrogen peroxide, and water) used to generate the PAA. Further, in any embodiment, the stability of the organic peroxide solution may be impacted by environmental considerations such as ambient temperature, direct sunlight, and storage location.

Generation of PAA online with immediate use would eliminate the need for stabilizing compounds such as etidronic acid. Etidronic acid is a phosphorous containing compound that will eventually be deposited in waste water treatment systems. Phosphate compounds can lead to eutrophication in the environment.

Equivalents and alternatives along with obvious changes and modifications are intended to be included within the scope of the present disclosure. Accordingly, the foregoing disclosure is intended to be illustrative, but not limiting, of the scope of the disclosure as illustrated by the appended claims.

## EXAMPLES

## Example 1:

One ml of concentrated PAA (containing 15-17% of PAA by weight on the day of formulation) was mixed in one gallon of water. The concentration of the diluted solution was measured using a standard PAA titration kit. Measurements were taken at one-week intervals for a total of 16 weeks. The results are summarized in Table 1 below.

TABLE 1

| Week after initial formulation | PAA Concentration |
|--------------------------------|-------------------|
| Week 1                         | 70-75ppm          |
| Week 2                         | 60ppm             |
| Week 3                         | 60-65ppm          |
| Week 4                         | 50ppm             |
| Week 5                         | 55ppm             |
| Week 6                         | 40-45ppm          |
| Week 7                         | 50-55ppm          |
| Week 8                         | 50ppm             |
| Week 9                         | 40-45ppm          |
| Week 10                        | 40-45ppm          |
| Week 11                        | 40-45ppm          |
| Week 12                        | 40ppm             |
| Week 13                        | 45ppm             |
| Week 14                        | 55-60ppm          |
| Week 15                        | 40-45ppm          |
| Week 16                        | 35-40ppm          |

As shown above, the solution had a maximum PAA concentration after 1 week, and the PAA concentration decreased as the solution aged. These results confirm the volatile nature of PAA and the need for online production to ensure sufficient PAA concentration for antimicrobial applications.

The above specific example embodiments are not intended to limit the scope of the claims. The example embodiments may be modified by including, excluding, or combining one or more features or functions described in the disclosure. The description of the present disclosure has been presented for purposes of illustration and description but is not intended to be exhaustive or limited to

the embodiments in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the disclosure. The illustrative embodiments described herein are provided to explain the principles of the disclosure and the practical application thereof, and to enable others of ordinary skill in the art to understand that the disclosed embodiments may be modified as desired for a particular implementation or use. The scope of the claims is intended to broadly cover the disclosed embodiments and any such modification.

## CLAIMS

### What is claimed is:

1. A method of producing an organic peroxide comprising:  
introducing an organic solution and a peroxide solution into a mixing tank to form a mixture;  
5 circulating the mixture over a fixed catalyst bed to form the organic peroxide;  
measuring a concentration of the organic peroxide in the mixture; and  
removing at least a portion of the mixture when the concentration reaches a set value.

2. The method according to claim 1, wherein the peroxide solution comprises hydrogen  
10 peroxide and water.

3. The method according to claim 2, wherein the peroxide solution comprises 10 to 50  
wt% of hydrogen peroxide based on a total weight of the peroxide solution.

4. The method according to claim 1, wherein the organic solution comprises water and  
15 an organic acid having 1 to 8 carbon atoms.

5. The method according to claim 4, wherein the organic solution comprises 10 to 50  
wt% of the organic acid based on a total weight of the organic solution.  
20

6. The method according to claim 4, wherein the organic acid is acetic acid.

7. The method according to claim 5, wherein the organic acid is acetic acid.

8. The method according to claim 1, wherein the fixed catalyst bed comprises an acid  
25 resin.

9. The method according to claim 1, wherein the set value is between 50 and 2000 ppm  
of the organic peroxide.  
30

10. A system for online production of an organic peroxide comprising:  
a mixing tank;  
a peroxide supply in fluid communication with the mixing tank and configured to supply a  
peroxide solution to the mixing tank;  
5 an organic supply in fluid communication with the mixing tank and configured to supply an  
organic solution to the mixing tank;  
a circulator configured to contact contents of the mixing tank with a fixed catalyst bed;  
a sensor configured to measure a concentration of an organic peroxide in a mixture of the  
peroxide solution and the organic solution; and  
10 an outlet configured to remove the mixture from the system in response to the sensor  
measuring the concentration as being equal to or greater than a set value.

11. The system according to claim 10, wherein the peroxide solution comprises hydrogen  
peroxide and water.

12. The system according to claim 11, wherein the peroxide solution comprises 10 to 50  
wt% of hydrogen peroxide based on a total weight of the peroxide solution.

13. The system according to claim 10, wherein the organic solution comprises water and  
an organic acid having 1 to 8 carbon atoms.

14. The system according to claim 13, wherein the organic solution comprises 10 to 50  
wt% of the organic acid based on a total weight of the organic solution.

15. The system according to claim 13, wherein the organic acid is acetic acid.

16. The system according to claim 14, wherein the organic acid is acetic acid.

17. The system according to claim 10, wherein the fixed catalyst bed comprises an acid  
resin.

18. The system according to claim 10, wherein the set value is between 50 and 2000 ppm  
of the organic peroxide.

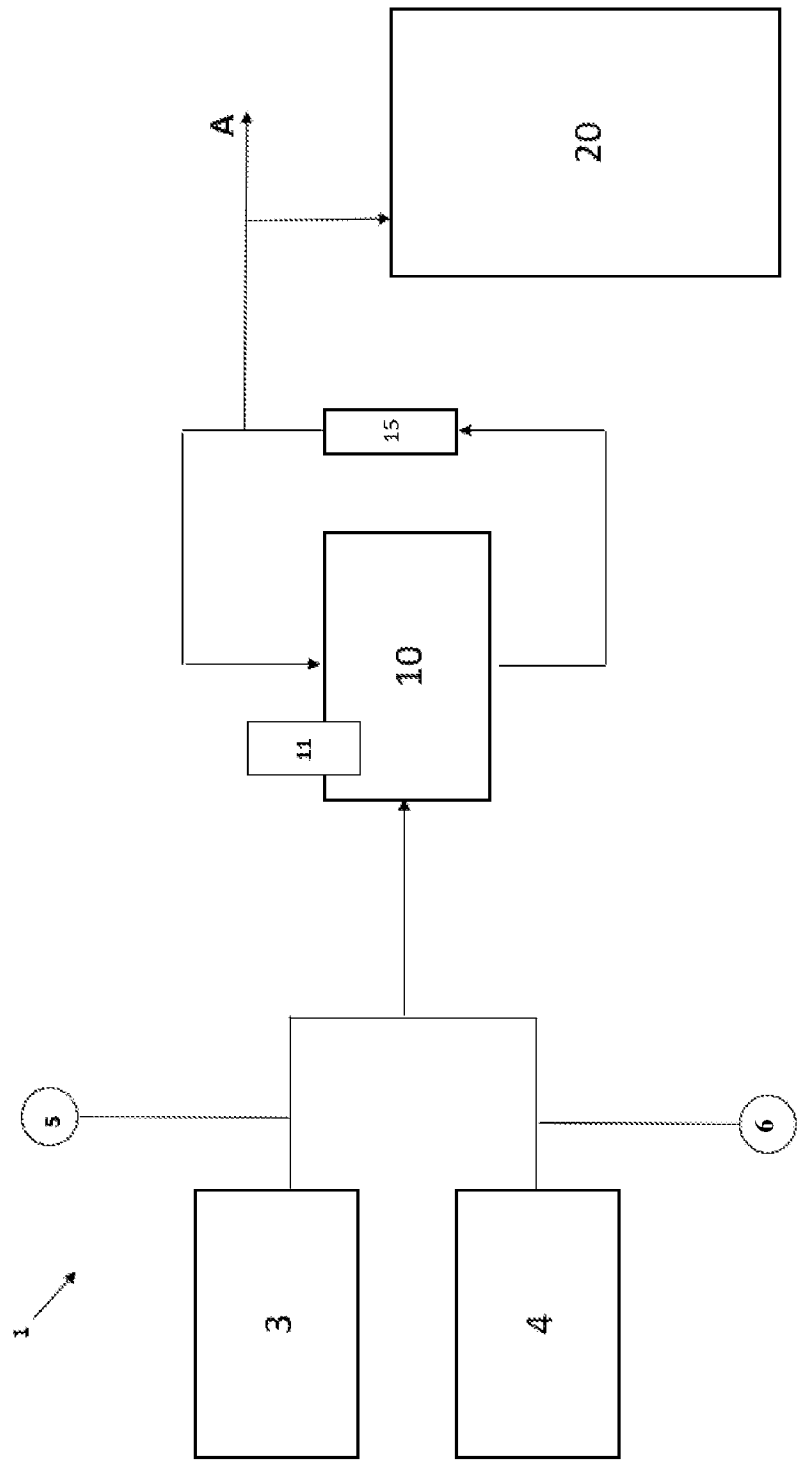


FIG. 1

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 19/24516

A. CLASSIFICATION OF SUBJECT MATTER  
 IPC(8) - B01J 27/053; B01J 31/02; C07C 407/00 (2019.01)  
 CPC - B01J 27/053; B01J 31/0225; C07C 407/00

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)

See Search History Document

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

See Search History Document

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

See Search History Document

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                    | Relevant to claim No. |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| X         | US 2008/0095677 A1 (McSherry et al.) 24 April 2008 (24.04.2008); Abstract, para[0005], para[0201], para[0092], para[0119], para[0079], para[0108], para[0083], para[0093], para[0178] | 1-9                   |
| A         | US 9,845,290 B2 (Ecolab USA Inc.) 19 December 2017 (19.12.2017); entire document                                                                                                      | 1-9                   |
| A         | US 5,122,538 A (Lokkesmoe et al.) 16 June 1992 (16.06.1992); entire document                                                                                                          | 1-9                   |
| A         | US 2009/0314652 A1 (Buschmann et al.) 24 December 2009 (24.12.2009); entire document                                                                                                  | 1-9                   |

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

☐ See patent family annex.

\* 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

08 July 2019

Date of mailing of the international search report

23 JUL 2019

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. 571-273-8300

Authorized officer:

Lee W. Young

PCT Helpdesk: 571-272-4300  
 PCT OSP: 571-272-7774

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 19/24516

## 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:  
-- see extra pages --

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.:  
Claims 1-9

### 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.

**Box III Lack of Unity of Invention**

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 searched, the appropriate additional search fees must be paid.

Group I: Claims 1-9 directed to a method of producing an organic peroxide.

Group II: Claims 10-18 directed to a system for online production of an organic peroxide.

The inventions listed as Groups I-II 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 invention of Group II includes the special technical feature of a system for online production of an organic peroxide comprising: a peroxide supply in fluid communication with the mixing tank; an organic supply in fluid communication with the mixing tank; a circulator configured to contact contents of the mixing tank with a fixed catalyst bed; a sensor configured to measure a concentration of an organic peroxide in a mixture of the peroxide solution and the organic solution; and an outlet configured to remove the mixture from the system, not required by the claims of Group I.

**COMMON TECHNICAL FEATURES**

Groups I and II share the common technical feature of producing an organic peroxide comprising: introducing an organic solution and a peroxide solution into a mixing tank to form a mixture; circulating the mixture over a fixed catalyst bed to form the organic peroxide; measuring a concentration of the organic peroxide in the mixture; and removing at least a portion of the mixture when the concentration reaches a set value. However, this shared technical feature does not represent a contribution over prior art as being anticipated by US 2008/0095677 A1 to McSherry et al., which teaches producing an organic peroxide (Abstract 'The present invention relates to apparatus and methods for making a peroxycarboxylic acid') comprising: introducing an organic solution (para[0005] 'the second reagent vessel can be configured for containing a liquid carboxylic acid composition') and a peroxide solution (para[0005] 'The first reagent vessel can be configured for containing a liquid hydrogen peroxide composition') into a mixing tank to form a mixture (para[0201] 'reagent conduit can define mixing chamber for the reagents'; para[0088] 'The conduit of the mixture of short chain carboxylic acid (e.g., acetic acid) and hydrogen peroxide'); circulating the mixture over a fixed catalyst bed (para[0092] 'pretreatment column can include any of a variety of cation exchangers, such as strong cation exchangers. Suitable cation exchangers for the pretreatment column include polystyrene sulfonic acid resins'; see instant specifications pg 3 ln 15-22) to form the organic peroxide (para[0119] 'Reactor column is packed with strong acid catalyst (not shown). Inside reactor column, the reaction mixture of hydrogen peroxide and carboxylic acid react as they move through the strong acid catalyst at a predetermined, controlled flow rate. System parameters, such as column size and reagent flow rate, for the peroxycarboxylic acid generator are selected and/or controlled to provide sufficient residence time of the reaction mixture on the strong acid catalyst for conversion into the desired peroxycarboxylic acid composition'); measuring a concentration of the organic peroxide in the mixture (para[0079] 'The reagent flow system can monitor the peroxycarboxylic acid composition after the reaction catalyst, for example, at an outlet from the last reaction catalyst column. This system can determine whether the composition includes the desired concentration of peroxycarboxylic acid'); removing at least a portion of the mixture when the concentration reaches a set value (para[0119] 'System parameters, such as column size and reagent flow rate, for the peroxycarboxylic acid generator are selected and/or controlled to provide sufficient residence time of the reaction mixture on the strong acid catalyst for conversion into the desired peroxy carboxylic acid composition. Generator design and process control are described in more detail herein below. The peroxycarboxylic acid composition is discharged from a reaction column via third line, for example, into a holding tank').

As the common technical features were known in the art at the time of the invention, these cannot be considered special technical feature that would otherwise unify the groups.

Therefore, Groups I-II lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.