SUMMARY

In an aspect of the present disclosure, there is provided a method for producing a biocide comprising:

providing a solution of a hypochlorite oxidant;

providing a solution of an ammonium salt;

mixing said solution of a hypochlorite oxidant with said solution of an ammonium salt to form a mixture at an initial ammonium:hypochlorite molar ratio of greater than 1:1 while monitoring the conductivity of the mixture; and

reducing the ammonium:hypochlorite molar ratio until the conductivity reaches a maximum;

wherein a final molar ratio of said ammonium to said hypochlorite oxidant is less than 1:1.

The present disclosure seeks to provide a method for producing a biocide.

There is thus provided in accordance with a preferred example of the present disclosure a method for producing a biocide including: providing a solution of a hypochlorite oxidant; providing a solution of an ammonium salt; and mixing the solution of a hypochlorite oxidant with the solution of an ammonium salt; wherein the molar ratio of the ammonium to the hypochlorite oxidant is less than 1:1. Preferably, the hypochlorite oxidant is sodium hypochlorite.

In accordance with a preferred example of the present disclosure, the solution of a hypochlorite oxidant is prepared by diluting a concentrated solution of about 8-18% with water immediately prior to use. Preferably, the solution of a hypochlorite oxidant has a concentration from about 1000 to about 20,000 ppm, more preferably from about 3000 to about 10,000 ppm, and most preferably from about 3500 to about 7000 ppm.

In accordance with a preferred example of the present disclosure, the ammonium salt is selected from ammonium bicarbonate, ammonium carbonate, ammonium carbamate, ammonium hydroxide, ammonium sulfamate, ammonium bromide, ammonium chloride and ammonium sulfate. Preferably, the ammonium salt is selected from ammonium carbamate, ammonium bromide,

ammonium hydroxide and ammonium sulfate. Most preferably, the ammonium salt is ammonium carbamate. In accordance with another preferred example, the ammonium salt is a mixture of two or more ammonium salts.

In accordance with a preferred example of the present disclosure, the solution of an ammonium salt is prepared by diluting a concentrated solution of about 15-50% with water or with the solution of a hypochlorite oxidant immediately prior to use. Preferably, the solution of an ammonium salt has a concentration from about 1,000 to about 50,000 ppm, more preferably, from about 12,000 to about 30,000 ppm. In accordance with a preferred example of the present disclosure, the solution of an ammonium salt further includes a base. Preferably, the base is sodium hydroxide.

Preferably, the method further includes monitoring the conductivity of the biocide. In accordance with a preferred example of the present disclosure, the method includes: providing an amount of the solution of an ammonium salt; adding a

plurality of amounts of the solution of a hypochlorite oxidant to the amount of the solution of an ammonium salt under mixing conditions; measuring the control parameter after the addition of each discrete amount of the solution of a hypochlorite oxidant; and ceasing to add amounts of said solution of a hypochlorite oxidant when a maximum in the conductivity is observed after the observation of a conductivity minimum.

In an alternative example, the method includes: mixing a stream of a hypochlorite solution with a stream of an ammonium salt solution in a mixing chamber at an ammonium:hypochlorite molar ratio of greater than 1:1; holding the flow rate of one of the streams constant and gradually increasing or decreasing the flow rate of the other of the streams in order to decrease the ammonium:hypochlorite molar ratio; monitoring the value of the conductivity in a stream leaving the mixing chamber; and selecting an ammonium:hypochlorite molar ratio to be equal to the ammonium:hypochlorite molar ratio wherein the conductivity value has a local maximum. In one example, the monitoring is continuous. In an alternative example, the monitoring includes measuring the control parameter in discrete samples of the stream leaving the mixing chamber.

BRIEF DESCRIPTION OF THE DRAWING

The present invention will be understood and appreciated more fully from the following detailed description, taken in conjunction with the drawing in which:

Fig. 1 is a graph showing the change of conductivity during the production of a biocide and the results of microorganism kill tests using the biocide;

Fig. 2 is a graph showing the change of conductivity during the production of a biocide and the results of microorganism kill tests using the biocide;

Fig. 3 is a graph showing the change of conductivity during the production of a biocide and the results of microorganism kill tests using the biocide;

Fig. 4 is a graph showing the ratio of hypochlorite:ammonium salt used to produce a biocide for a packaging machine and the level of volatile fatty acids produced by microorganisms in the packaging machine over time.

CLAIMS

1. A method for producing a biocide comprising:

providing a solution of a hypochlorite oxidant;

providing a solution of an ammonium salt;

mixing said solution of a hypochlorite oxidant with said solution of an ammonium salt to form a mixture at an initial ammonium:hypochlorite molar ratio of greater than 1:1 while monitoring the conductivity of the mixture; and

reducing the ammonium:hypochlorite molar ratio until the conductivity reaches a maximum;

wherein a final molar ratio of said ammonium to said hypochlorite oxidant is less than 1:1.

2. The method according to claim 1, wherein said hypochlorite oxidant is sodium hypochlorite.

3. The method according to claim 1 or 2, wherein said providing a solution of a hypochlorite oxidant comprises diluting a concentrated solution of 8-18% with water immediately prior to use.

4. The method according to any one of claims 1 to 3, wherein said solution of a hypochlorite oxidant has a concentration from 1000 to 20,000 ppm.

5. The method according to any one of claims 1 to 4, wherein said solution of a hypochlorite oxidant has a concentration from 3000 to 10,000 ppm.

6. The method according to any one of claims 1 to 5, wherein said solution of a hypochlorite oxidant has a concentration from 3500 to 7000 ppm.

7. The method according to any one of claims 1 to 6, wherein said ammonium salt is selected from ammonium bicarbonate, ammonium carbonate, ammonium carbamate, ammonium hydroxide, ammonium sulfamate, ammonium bromide, ammonium chloride and ammonium sulfate.

8. The method according to any one of claims 1 to 7, wherein said ammonium salt is selected from ammonium carbamate, ammonium bromide, ammonium hydroxide and ammonium sulfate.

9. The method according to any one of claims 1 to 8, wherein said ammonium salt is ammonium carbamate.

10. The method according to any one of claims 1 to 9, wherein said ammonium salt is a mixture of two or more ammonium salts.

11. The method according to any one of claims 1 to 10, wherein said providing a solution of an ammonium salt comprises diluting a concentrated solution of 15-50% with water or with said solution of a hypochlorite oxidant immediately prior to use.

12. The method according to any one of claims 1 to 11, wherein said solution of an ammonium salt has a concentration from 1,000 to 50,000 ppm.

13. The method according to any one of claims 1 to 12, wherein said solution of an ammonium salt has a concentration from 12,000 to 30,000 ppm.

14. The method according to any one of claims 1 to 13, wherein said solution of an ammonium salt further comprises a base.

15. The method according to claim 14, wherein said base is sodium hydroxide.

16. The method according to claim 1, wherein said method comprises:

providing an amount of said solution of an ammonium salt;

adding a plurality of amounts of said solution of a hypochlorite oxidant to said amount of said solution of an ammonium salt under mixing conditions;

measuring the conductivity after the addition of each amount of said solution of a hypochlorite oxidant; and

ceasing to add amounts of said solution of a hypochlorite oxidant when a maximum in the conductivity is observed after the observation of a conductivity minimum.

17. The method according to claim 1, wherein said method comprises:

mixing a stream of a hypochlorite solution with a stream of an ammonium salt solution in a mixing chamber at an ammonium:hypochlorite molar ratio of greater than 1:1;

holding the flow rate of one of said streams constant and gradually increasing or decreasing the flow rate of the other of said streams in order to decrease said ammonium:hypochlorite molar ratio;

monitoring the value of the conductivity in a stream leaving said mixing chamber; and

selecting an ammonium:hypochlorite molar ratio to be equal to the ammonium:hypochlorite molar ratio wherein the conductivity value has a local maximum.

18. The method according to claim 17, wherein said monitoring is continuous.

19. The method according to claim 17, wherein said monitoring comprises measuring the control parameter in discrete samples of said stream leaving said mixing chamber.