

White Paper - Cleaning and Sanitizing Fresh Produce using High Chlorine

Introduction

Various microorganisms cause significant financial losses due to decay as fresh produce travels through marketing and handling channels from producer to consumer. Some of the more destructive organisms include *Erwinia* spp bacteria and *Geotrichum candidum* mold, both of which are pathogenic to a wide variety of fruits and vegetables and can cause significant losses within the industry on an annual basis. These organisms are prevalent in the fields where produce is grown, and can be spread during and after harvest through subsequent handling. These organisms, and many others, can be spread during produce washing operations, thus it is desirable to apply a sanitizer to fruits and vegetables to reduce the likelihood that otherwise sound fruit may become infected with decay causing pathogens.

Cleaning of produce should precede sanitizing treatments. Cleaning and rinsing or washing in water removes dirt, soil and plant juices (sap) and reduces the size (number) of the microbial population.

However, washing alone does not eliminate microbes. Produce items that contain adhering soil can be washed in cool water containing a mild alkali cleaning agent such as sodium carbonate, sodium bicarbonate, sodium sesquicarbonate, sodium metasilicate or trisodium phosphate. After cleaning, the produce is ready to be sanitized.

Sanitizing agents destroy the vegetative cells of micro-organisms but sanitizing agents do not sterilize the produce because some microbial spores, and even a few vegetative cells, generally survive treatment with sanitizing agents.

Chlorine is the most widely used sanitizer in food processing operations. It has a number of advantages including:

- It kills micro-organisms rather rapidly;
- It is safe for consumers;
- It has no adverse effects on the food;
- It is economical;
- It is scalable system, implemented in operations of any size or scale of use
- It is readily soluble in water; and
- It is easily tested for solution concentration.

HG-602 High chlorine Blue I analyzer provides continuous chlorine and pH measurements while controlling and balancing the process (chlorine and acid dosing control) with fast response time to changes in chlorine levels. Thus, optimizing chemical consumption and save operating costs.

Food industry: fruits and vegetables sanitization treatment

The predominant chemical used in the produce industry to address microbial concerns is chlorine, often in the form of sodium hypochlorite.

Chlorine must be used within a narrow pH range to ensure optimal chlorine activity in the solution. Chlorine dissociates into either an acid or ion form in water. HOCl is 100 times more powerful an oxidant and disinfectant than is the hypochlorite ion.

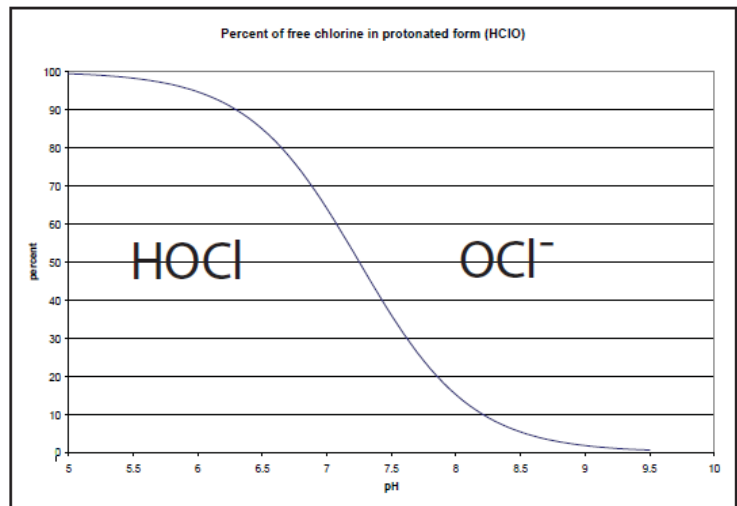
Consequently, the acid form (hypochlorous acid) is the preferred form for biological activity. Adding liquid sodium hypochlorite to the water results in an increase of pH in the solution, often above the narrow optimal range of pH 6.5-7.5. The chlorine effectiveness

declines with increased pH. This requires operators to employ additional equipment to monitor and control the pH. Sensing, feedback, and control systems are often utilized to balance both chlorine and pH levels in produce cleaning and sanitizing operations.

It is important to monitor and control the chlorine levels in this application.

It's important to sanitize produce properly. This is especially true for green leafy vegetables grown close to the soil and fruits eaten with the peeling on.

Sanitization of produce is an important issue in the agricultural industry. More efficient and less costly methods of sanitization would provide a significant benefit to the supply and distribution channels of this industry.



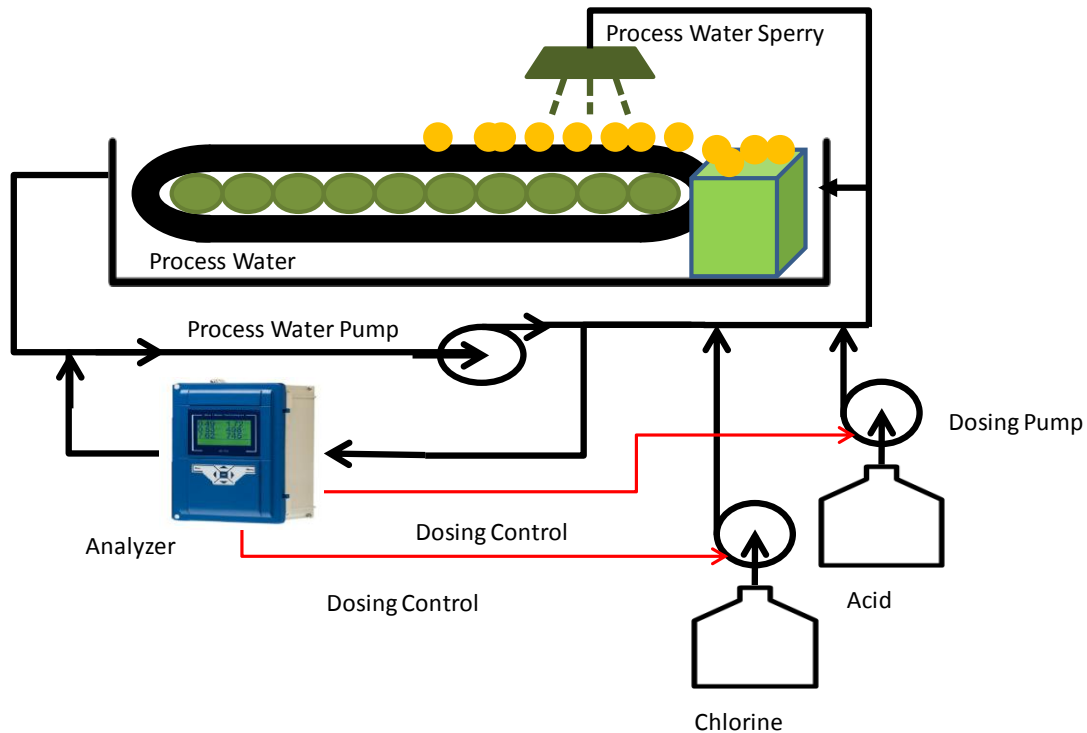


Figure 1: Typical fruits and vegetables sanitization treatment plant

Overview of Application

A conventional way of sanitizing produce comprises washing or spraying of objects, such as fruit or more particular tomatoes and citrus fruit, in conveyor systems from a fixed overhead spray manifold as the objects are being scrubbed or cleaned in a conveyor brush bed. The purpose for washing the tomatoes and citrus fruit may include, for example, not only removal of field dirt, contaminants and pesticides, but also, particularly in the case of high-pressure spraying, removal of scale insects or fungal microorganisms which might otherwise mar the appearance or cause later spoilage of the fruit.

Typically, the fruit are loaded onto a brush bed conveyor system which aligns the fruit into the linear pockets between elongated cylindrical brush rollers, which are aligned transversely to the movement of the conveyor. A system of nozzles on a fixed manifold located above the brush bed rollers directs fluid onto the fruit passing below it. The rollers brush, scrub and rotate the fruit while the fruit is being simultaneously spray washed from above by the fixed spraying system. As described in one or more of the aforementioned patents, the solution may be filtered and re-circulated for conservation and economy.

The important factors affecting the germicidal properties of chlorine include the acidity (pH) of the solution, the concentration of the chlorine in the solution and the temperature of the solution. The most economical and readily available form of chlorine is bleach. Bleach is a solution of sodium hypochlorite (NaOCl) in water. Sodium hypochlorite solutions are very alkaline with a pH in excess of 9 or 10. At this high pH, bleach is not a very effective germicide. The pH of the bleach solution must be reduced to between 6 and 7 in order to form hypochlorous acid (HOCl). Hypochlorous acid is the most germicidal form of chlorine in aqueous media. Thus, when bleach is added to water to form a germicidal sanitizing solution it is necessary to adjust its pH to between 6 and 7. The easiest and most economical way to do this is to add distilled vinegar to the bleach-water mixture. When enough vinegar is added to adjust the pH of the solution to between 4 and 5, the solution is mostly hypochlorous acid (HOCl), and its germicidal power is greatest. However, when the solution pH is between 4 and 5 it is very corrosive to metals. Thus, using the bleach solution at a pH between 6 and 7 gives satisfactory germicidal power and the solution is not excessively corrosive. When the pH of a bleach solution is decreased to below 4.0, deadly chlorine gas is formed. Thus, it is important to only reduce the pH of the bleach solution to not less than about 6.

Vegetative cells of microbes are easily killed by chlorine, but bacterial and mold spores are not. Thus, surfaces treated with chlorinated water may contain high numbers of surviving spores. The resistance of spores to the killing power of chlorine is due to their relatively impervious and dense outer coating or wall. The chlorine must first penetrate the wall of the spore to reach and oxidize the internal protoplasm. Not only must the chlorine penetrate the spore wall to attack and kill the spore; microbes exude a complex polysaccharide-based material when they are present on a surface. This sticky, protective coating forms a complex film around the cells and spores which is called a "biofilm". Thus, the chlorine in a sanitizing solution must get past the protective biofilm coating in order to attack the cells and spores embedded in it. In order to assist the chlorine to penetrate the spore wall and to gain access to microscopic "nooks and crannies" on treated surfaces a surfactant—a "wetting agent"—can be added to the bleach-vinegar-water sanitizing solution. Sodium lauryl sulfate is a good (FDA-approved) surfactant for this purpose as is a material referred to as Polysorbate 60 or TWEEN 60. This is a wetting agent that has the chemical name polyoxyethylene sorbitan monostearate. Proper cleaning and sanitation acts to prevent or retard the formation of biofilms.

Effective destruction of microbes on produce can be achieved by placing the produce in a “pool” of the sanitizing agent. The longer the produce remains in the sanitizing solution the greater will be the total number of microbes destroyed. It is important to remember that produce should be chilled after harvest and should be kept cool or cold until prepared for consumption. Therefore, the sanitizing bleach treatment should be done using cool water that is about 20°F warmer than the produce temperature. Dwell time of the produce in the sanitizing solution can range from between 1 to 5 minutes or 10 minutes. After the produce is removed from the sanitizing solution it can be allowed to drain for several minutes prior to packaging it or placing it on display. The residual chlorine on the produce does not impart a “bad” flavor and is dissipated in a few hours. The vinegar (acetic acid) concentration in the sanitizing solution is so weak that no “acid” or vinegar taste is apparent on the produce.



Regulations

Regulations authorities such as the FDA, allows fruits and vegetables to be washed in water containing up to 0.2 percent sodium hypochlorite (for example: The U.S. FDA regulation 21 CFR 173.315).

Blue I Solution

Technology:

Multi-parameter analyzer based on Amperometric method

Objective:

- Measurement of free chlorine up to 200ppm
- Control the sanitization process
 - Suite for fruits and vegetables sanitization treatment
 - Maintain required level of active chlorine
 - Optimization of chlorine consumption
 - Prolong fruits and vegetables shelf life

Technology Description:

The high chlorine measurement is based on pH compensation to ensure acid and chlorine control as well adequate concentration of active chlorine in the cleaning water.

One of the most established techniques for measuring chlorine levels is the amperometric method. With this method, chlorine levels in the water are continuously monitored by a sensor probe that contains the electrolyte Potassium Chloride (KCl). The probe is located in a state of the art dedicated flow cell, and as the water travels by, the chlorine moves across the membrane located on the bottom of the probe and reacts with the KCl to generate an electric current. The probe then measures this current to determine the chlorine concentration in the water. The concentration will determine the strength of the current, delivering a stronger current when the concentration is high.



Blue I Water Technologies Ltd. Proprietary Information

23 Ha'melacha St. Rosh Ha'ayin 48091, Israel, Tel: 972-9-7680004, Fax: 972-9-7652331

www.blueitechnologies.com



Technology benefits

- Maintenance advantages
 - Low and simple maintenance
 - membrane cap replacement approximately once a year
 - Electrolyte replacement every 3 month
 - long lifetime
 -
- Performances advantages
 - Measurement and control F-CL range: 0-200 ppm
 - Measurement and control of pH range
 - Measurement Method: Continues
 - Measurement accuracy (+/- 5%)
 - Precise feedback for chlorine and acid dosing control
- System benefits
 - Six independent relays for equipment control
 - Having means to measure additional parameters such as Redox, conductivity, turbidity and temperature.

Summery

It is important to monitor and control the chlorine levels when cleaning and Sanitizing Fresh Produce.

HG-602 High chlorine Blue I analyzer provides continues chlorine and pH measurements while controlling and balancing the process with fast response time to changes in chlorine levels. Thus, maintain adequate active chlorine levels while optimizing chemical consumption and saving operating costs.

As HOCl is 100 times more powerful as an oxidant and disinfectant than hypochlorite ion, chlorine must be used within a narrow pH range to ensure optimal chlorine activity in the solution. Chlorine dissociates into either an acid or ion form in water. The acid form (hypochlorous acid) is the preferred form for biological activity. Adding liquid sodium hypochlorite to the water results in an increase of pH in the solution, often above the narrow optimal range of pH 6.5-7.5. This requires operators to employ additional equipment to monitor and control the pH.

Sensing, feedback, and control systems are often utilized to balance both chlorine and pH levels in produce cleaning and sanitizing operations.

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