



Power Breezer as a means of Disinfecting Large Surfaces using Covid-19 Approved Chlorine-based Liquid Solutions

M. Dovrat, O. Baharav, F. Habubilla, Q. Archer
Breezer Holdings, LLC

Abstract

In recent days, there is a growing interest in using Power Breezer evaporative coolers as a means of disinfection against Covid-19. While the Power Breezer is a very effective evaporative cooler, it was not originally designed as a chemical sprayer or applicator. In this study, we show how to use the Power Breezer as a means of depositing products that meet the US Environmental Protection Agency (EPA) criteria for use against SARS-CoV-2 (the cause of COVID-19).¹ In particular, we demonstrate two methods of creating a thin film of disinfecting solution on surfaces.

Introduction

The Power Breezer is an industrial-grade evaporative cooler capable of discharging 4-5 gal/hr of water mist. It throws clean water onto a high velocity rotating disk (the atomizer). Water is rotated and thrown (by centrifugal force) onto small walls on the disk's perimeter, which serve to break down the water into vapor or mist. This mist is added to a powerful air stream generated by a strong fan situated at the back of the atomizer. The mist evaporates in the air, serving to cool and humidify it. The mist is generally felt at a distance of up to 50 ft before it completely evaporates (depending on the ambient conditions). This paper will demonstrate how to use the Power Breezer as a material deposition sprayer or applicator in order to create a thin wet film over a large area, which may be utilized in disinfecting surfaces.

There is a growing interest in using Power Breezer in order to disinfect surfaces against COVID-19. The list of disinfectants compiled by the EPA¹ mentions many commercially available products and materials claiming or certified to be effective against coronavirus. These can be classified into three main groups according to their active ingredient - quaternary ammonium, sodium hypochlorite, and alcohol. The US Department of Health Center of Disease Control and Prevention (CDC) specifically recommends using diluted household bleach² solutions in order to disinfect surfaces against COVID-19.³ We therefore concentrate in this

¹ "List N: Disinfectants for Use Against SARS-CoV-2 | Pesticide"

<https://www.epa.gov/pesticide-registration/list-n-disinfectants-use-against-sars-cov-2>.

² Bleach means a liquid solution where sodium hypochlorite is the main active ingredient typically available off the shelf at 5.25%-8.25% concentration

³ "Clean & Disinfect - CDC." 6 Mar. 2020,

<https://www.cdc.gov/coronavirus/2019-ncov/prepare/cleaning-disinfection.html>.

paper on using chlorine based solutions, but the results shown will be equally applicable to quaternary ammonium solutions as well.

Household bleach is composed of 2 main ingredients. The active ingredient in most household bleach is sodium hypochlorite (NaOCl, the sodium salt of hypochlorous acid HOCl) and a stabilizing agent is added (sodium hydroxide, NaOH) in order to slow down the decomposition of the active ingredient. The dilution ratio of household bleach mentioned in [3] for use as a disinfectant is approximately 1:50 (“5 tablespoons per gallon of water”, or “4 teaspoons per quart”, see the table below).⁴

| Mixing Instruction | Resulting Dilution Ratio |
|--------------------------|--------------------------|
| 5 tablespoons per gallon | 5:256, or 1:51.2 |
| 4 teaspoons per quart | 4:192 or 1:48 |

However, the active ingredient concentration is still rather vague, since the concentration of the active ingredient in household bleach solutions ranges from 3–8.25%. Reference [3] (from CDC) further reduces the range of active ingredients most abundant in US household bleach to 5.25–6.15%, resulting in an active ingredient concentration ranging in 1,005–1,255 PPM (parts per million) in water. This concentration is consistent with similar instructions from the Australian Department of Health pertaining to disinfection principles for COVID-19, mentioning the concentration of 1000 PPM of hypochloric acid (the active ingredient in bleach).⁵

Experiment

In order to create a wet film over a large surface area, we have used a Power Breezer unit (2019 model and after), with a 1 HP fan motor (the standard, with 5 or 6 blades impellers).

We prepared a diluted bleach solution (1,000 PPM) and put it into the unit. We ran the Power Breezer in swing (oscillation) mode over a large concrete floor and measured the time it takes for a thin film of diluted bleach solution to form over the entire area of coverage. We also measured the size of the area where this wet film has formed.

We operated the machine in 2 modes:

1. “As supplied”, (Method 1) with the water valve open all the way. The mist generating capacity is ~4 gallons per hour.

⁴ The standard sizes are 3 teaspoons per tablespoon, 64 tablespoons per quart, and 4 quarts per gallon. See "Volume Converter." <https://www.unitconverters.net/volume-converter.html>.

⁵ "Environmental cleaning and disinfection principles" <https://www.health.gov.au/sites/default/files/documents/2020/03/environmental-cleaning-and-disinfection-principles-for-covid-19.pdf>.



2. Bypassing the water valve by rejoining the tubes using a [3/8" od x 3/8" od quick connect coupling](#) (Method 2). The mist generating capacity is increased by 20% to ~5 gallons per hour.



The temperature at the time of the experiment was 54°F (12°C), and the relative humidity was 60%.

Results

Method 1: When using the “as supplied” method with the water valve open all the way, a noticeable wet film appeared after 4 hours over a sector of 60° (the unit’s swing angle) up to a distance of 60 ft away from the unit.

Method 2: When using the valve bypass (by a non-reducing coupling or simply a longer tube), a noticeable wet film appeared after 10 minutes over a sector of 60° (the unit’s swing angle) up to a distance of 30 ft.



Discussion

As seen in the results, we have been able to show two methods of obtaining a wet film of a diluted bleach disinfecting solution over a large surface area, for a period greater than 10–30 minutes (the recommendation for most of the materials appearing on the EPA list [1]).

Although the experiment was conducted using diluted bleach, the results may be equally applicable to the other family of disinfectants composed of quaternary ammonium diluted in water.

The recommendations for use are as follows:

Formula Preparation:

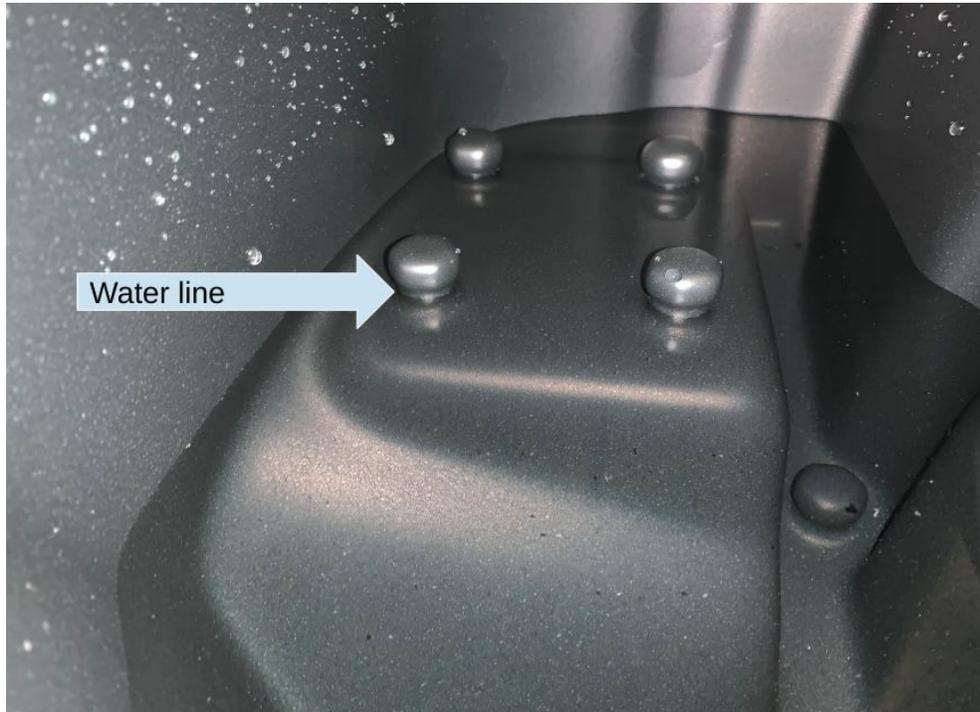
If there are no specific COVID-19 instructions on the manufacturers' labels, you may use the table below to prepare a diluted bleach solution with ~1,000–1,200 PPM active ingredients, according to the two outlined methods of use. Please use a volume measurement cup with the appropriate imperial units (fl oz, cups). Please fill water first (according to the volume specified) and add specified volume of bleach to the water.

| Original Strength of Bleach | Preparation of ~1 gallon of bleach disinfecting solution (15 minutes of operation per Method 1) | | | Preparation of ~20 gallons of bleach disinfecting solution (5 hours of operation per Method 2) | | |
|-----------------------------|---|----------|-----------------|--|------------|---------------|
| | Bleach | Water | Concentration | Bleach | Water | Concentration |
| 5% | 3.0 fl oz. | 1 gallon | 1,145 PPM | 7 cups | 20 gallons | 1,070 PPM |
| 5.25% | 2.5-3.0 fl oz. | 1 gallon | 1,005–1,202 PPM | 7 cups | 20 gallons | 1,123 PPM |
| 6.15% | 2.5 fl oz. | 1 gallon | 1,178 PPM | 6 cups | 20 gallons | 1,132 PPM |
| 8.25% | 1.75 fl oz. | 1 gallon | 1,113 PPM | 4.5 cups | 20 gallons | 1,144 PPM |

Method 1 (overnight 5 hours of disinfection):

1. Preparing the unit
 - a. First, fill the Power Breezer with 20 gallons of water as shown in the image below where the water line reaches the bottom of the 4 “towers” just above the rear casters.





- b. Add any commercial bleach solution to the water diluted per table above.
2. Disinfecting the area
 - a. Use one Breezer per approximately 3,000 square feet
 - b. Close all doors and windows
 - c. Set the Power Breezer fan to maximum and ensure the misting valve is in the fully open position.
 - d. The machine will mist for 5 hours after which the solution would run out and only the fan will keep running, the pump will go to idle mode (to reset the pump for a subsequent operation, power off the unit and turn it back on).
 - e. Open windows and doors, as soon as the visible film evaporates 10–30 minutes later (depending on ambient conditions) people can return to the disinfected area.

Method 2 (rapid 10–15 minutes disinfection)

1. Preparing the machine:
 - a. Disconnect the tubes from both sides of the water valves
 - b. Rejoin the tubes using a [3/8 in od x 3/8 in od connector](#) as shown in the picture below.



2. Preparing the solution:
 - a. Determine how many sections (30 feet range 60 degrees cone) are planned to be disinfected
 - b. Use one gallon of water per section and add any commercial bleach solution diluted per the table above. For a small quantity, you may want to fill the water into a bucket situated inside the tank in order that the water level will be high enough to pump.
3. Disinfecting the area:
 - a. Roll the Power Breezer to the desired area
 - b. Set the Power Breezer fan to maximum and ensure the misting valve is in the fully open position.
 - c. If there are no obstructions, run for 10–15 minutes until a visible film coats the surfaces.
 - d. If there are obstructions such as racks, boxes, machines, the process must be repeated after the machine has been shifted by 90 to 180 degrees
 - e. After completing the process open doors and windows if preset
 - f. As soon as the visible film evaporates 10–30 minutes depending on ambient conditions, people can return to the disinfected area.

Warnings:

1. **Do not mist directly on people.** In addition, as mentioned in [3] and surely on any manufacturer's package, the use of such chemicals should be in well ventilated areas due to their potential to irritate the skin, eyes, and respiratory system.⁶ In case of accidental direct misting, wash skin and eyes to avoid irritation, if the situation persists or deteriorates seek medical advice.
2. **Do not mix chemical solutions with any other chemicals.** The effect of combining cleaning solutions is not "additive", and is extremely dangerous. Two particular examples worth mentioning are mixing of bleach with the other materials mentioned in [1]. Mixing bleach (sodium hypochlorite) with quaternary ammonium will result in the release of

⁶ "Chemical Disinfectants | Guidelines Library - CDC."
<https://www.cdc.gov/infectioncontrol/guidelines/disinfection/disinfection-methods/chemical.html>.

highly toxic gases. Mixing bleach with hydrogen peroxide (another disinfectant) may result in a highly violent chemical reaction.⁷

3. **Do not exaggerate beyond the recommended concentration.** High concentrations (10X over the recommended and above 50,000 PPM, or 5%) are known to be highly corrosive⁸ to metals.⁹ At a long exposure (of days), concentrations as high as 500 PPM may also be corrosive.³ However, at the concentrations relevant to disinfecting surfaces (1,000 PPM), and the most common recommended exposure time of 10–30 minutes on the surface, corrosion should be negligible. An example study (by a commercial brand, but it is compared to a reference of sodium hypochlorite contained in bleach) has shown minimal corrosion of various metals after 30 days at a concentration of 1,000 PPM.¹⁰ In order to minimize the possibility of corrosion, the wet film should be removed after 10–30 minutes (in accordance with the manufacturers' instructions relevant to disinfection against COVID-19). Although bleach should evaporate, to eliminate the potential of long term corrosion it is recommended that floor and metal parts be wiped with water every two weeks.
4. **To mitigate the corrosive effects of the Breezer, we recommend a weekly running only water through the Breezers.** While we have not noticed any degradation during our experiments, due to the reactivity of the solution, there may be a long term effect to the Power Breezer atomizer or pump. These parts as many others are available for field replacements as spare parts.
5. **Do not spray alcohol with the Power Breezer.** The possibility of doing this was not checked, and it has the potential to be a very serious fire or explosive hazard. Do not attempt this.
6. **Be careful of slip hazards due to the liquid layer on floors and equipment.**

Conclusion

In conclusion, we have demonstrated how to create a film of chemical solution consistent with CDC recommendations for disinfecting surfaces against COVID-19. We have also demonstrated the Power Breezer's ability to form a film in two modes:

1. Overnight mode allowing the Power Breezer to be left unattended
2. A rapid 10–15 minute mode allowing to roll the Power Breezer among multiple work cells forming the CDC required film on surfaces within 10–15 minutes.

⁷ "Sodium hypochlorite - Wikipedia." https://en.wikipedia.org/wiki/Sodium_hypochlorite.

⁸ corrosion is a chemical reaction between reactive agents present in a wet film over a metal surface, which serves to degrade the metal over a period of time. See, for example, here: <https://corrosion-doctors.org/Modules/Modules.htm>

⁹ "Selection of stainless steels for handling sodium" <https://www.bssa.org.uk/topics.php?article=35>.

¹⁰ "Corrosion of Metals in Chlorine-Containing Disinfectant Solutions". https://www.texwipe.com/Content/Images/uploaded/documents/Technical-Data/TechNoteTexTab%20vs%20Bleach%20Corrosion_05-2018.pdf

