Post-harvest fresh produce wash water disinfection by submerged cold plasma non-chemical continuous treatment system

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Summary

Cold plasma water treatment is a possible solution for non-thermal disinfection washing of minimally processed fresh-cut produce. The reverse vortex gliding arc plasma systems created by scientists of the Nyheim Plasma Institute (NPI) at Drexel University can be used to disinfect delicate fresh produce with no adverse quality effects, low-cost operation, and no added chemicals. For this project, Drexel University scientists are collaborating with SmartWash Solutions and Sunterra Produce Traders East. The Drexel team will use its experience in commercialization of plasma water treatment, and will optimize the existing reverse vortex gliding arc plasmatron for the specifics of the food processing plant, validate this new system in the lab, and finalize this project by a full validation of the created prototype at an industrial-scale testing facility.

Benefits to the Industry

By developing a working method for non-thermal disinfection of minimally processed fresh-cut produce, disinfection of fresh produce can be done in an effective, less expensive, and less harmful manner. This method would be able to be used for large-scale disinfection of produce due to its lack of adverse quality effects, low-cost operations, and elimination of chemicals that are typically used to disinfect fresh produce.

Objectives

1. Construct and install a 100-gallon flow-through water tub for lab-scale testing.
2. Modify the reverse vortex gliding arc plasmatron electrode to fit the 100-gallon tub.
3. Optimize the existing 3-kW power supply for the newly constructed electrode.
4. Using the microbial "cocktail" (*E. coli* strains ATCC 2592, 35218, 11229, and 8739), validate the disinfection efficiency and generate the operating parameter space for the plasma system.
5. Using an increasing amount of organic load, validate the plasma disinfection efficiency.
6. Optimize the plasma system for industry-level testing, and perform testing at SmartWash Solutions facility in Salinas, CA.
7. Generate the intellectual property (patent applications), schematics, etc. for the commercial prototype system.

Methods

At the start of this project a 100-gallon rectangular tub will be welded and installed with water in/out to simulate an industrial system where water can be stationary or have constant flow. The Drexel team will use our designed 3 kW plasmatron system for this project and modify its electrode, which will be attached to the tub. The complete safety of the plasma system will be achieved by carefully grounding all external components and placing the plasmatron in the Faraday cage. A microbial cocktail consisting of different *E. coli* strains will be used to simulate cross-contamination seen during fresh produce washing. Standardized COD water will be created and admixed to simulate increased organic load. This plasma-treated water will be used to wash mixtures of non-inoculated and inoculated produce. Produce and the wash water samples will be tested microbiologically with 3M Petrifilm. The washed fresh produce will also be tested for quality changes.

Results to Date

The first three objectives of the project have been achieved:

- Custom-made stainless steel 100-gallon water tub was developed, constructed, and equipped with a submerged water pump that provides continuous water flow (**Figure 1**).
- The gliding arc plasmatron (**Figure 2**) was modified by using an atomization nozzle for water injection into the plasma stream. The plasmatron was connected by flange to the side of the 100-gallon water tub and submerged into the water volume (**Figure 3**).
- An existing 3kW plasma power supply was modified for the plasmatron. This power supply, which has 6 modules that regulate the plasma's power from 0.5 to 3 kW in steps, has been equipped with a high frequency ignitor that provides reliable plasma ignition at different air and water flow rates (**Figure 4**).

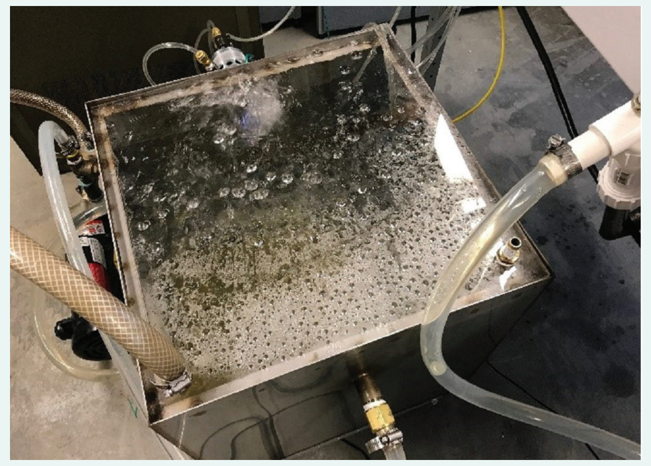

Figure 1. Stainless-steel water tub for wash water disinfection by submerged gliding arc plasma

Figure 4. Optimized plasma power supply connected to plasmatron

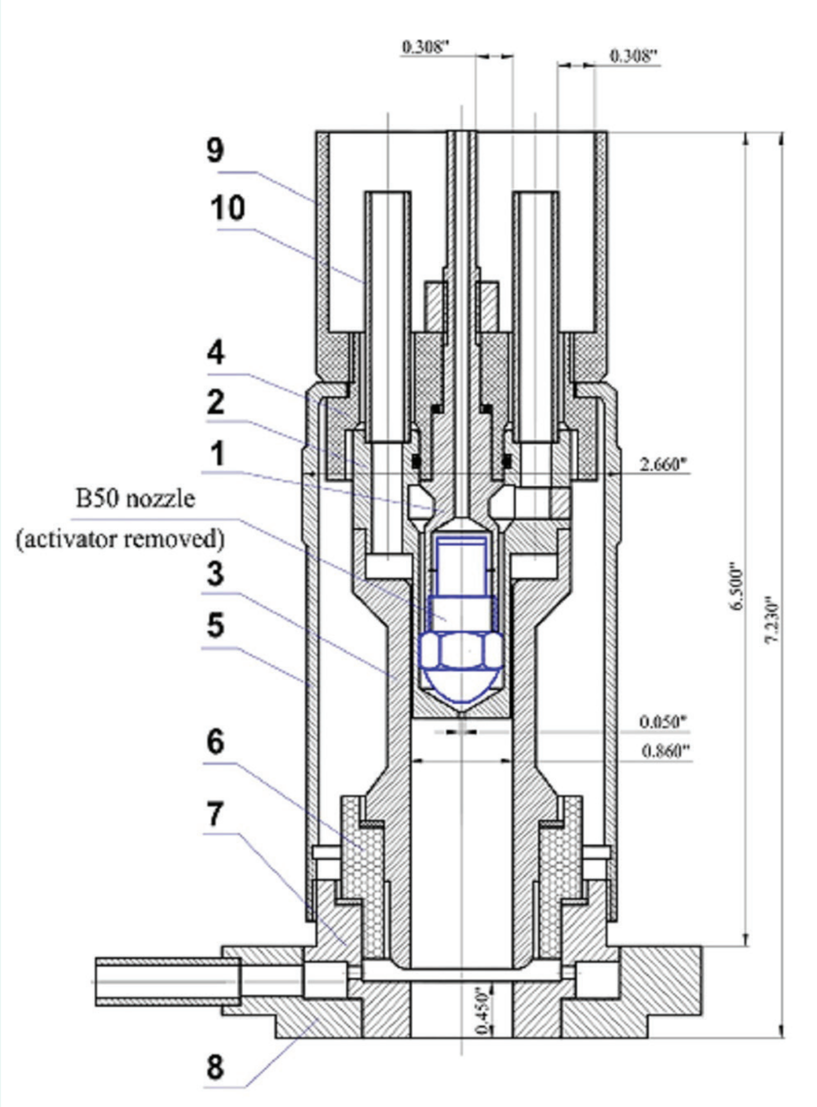

Figure 2. Schematic of gliding arc plasmatron

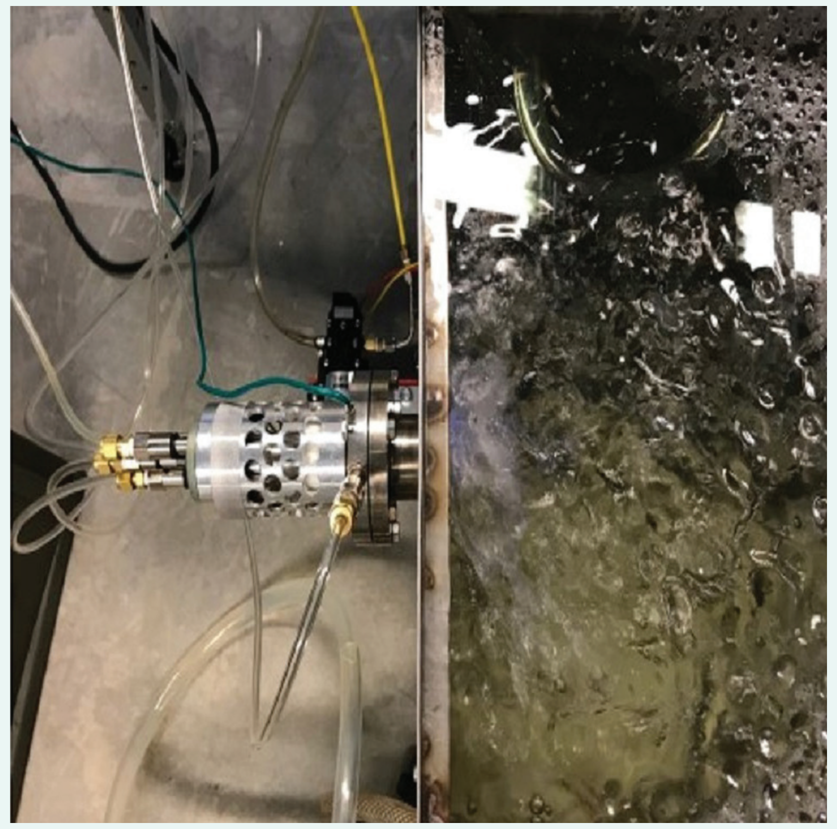

Figure 3. Modified plasmatron submerged into water tub